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THESIS

OFFICER EDUCATION AND TRAINING IN OCEANOGRAPHY
FOR ASW AND OTHER NAVAL APPLICATIONS

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Officer Education and Training in Oceanography

for ASW and Other Naval Applications

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ABSTRACT

This study into the knowledge and experience required for optimum performance by officers assigned to operational, R&D, and managerial duties in Anti-submarine Warfare concludes that oceanography should receive the major emphasis in an interdisciplinary graduate level program of the contributing disciplines in ASW. In planning education and training for officers in ASW and other oceanography-related duties the total Service experience should be considered. Oceanography graduate curricula are recommended which will provide knowledge for developing careers of three categories of officers who respectively will: "specialize" in ASW; become special duty "environmentalists"; and serve in technical management assignments. Billets are identified for each of these categories.

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I. INTRODUCTION

In a recent address, VADM H. E. Shear, Director of Antisubmarine Warfare Programs for the Chief of Naval Operations, enunciated a central theme which must be considered essential when establishing the needs of the Navy in oceanographic education and training. From his perspective as overall Navy manager of ASW Programs, Admiral Shear predicted that future success in ASW would be "directly proportional to our exploitation of oceanography in the solution of our problem." [1] This knowledge must be "second nature to Navymen from skippers to acoustic sensor operators." [1] He stated that the scientific and engineering problems in the field of ASW oceanography "are as great as those faced in any other scientific discipline or field of endeavor." The primary goal of the Naval Oceanographic Programs must be the continual search for knowledge in oceanography so that our operational ASW forces will better understand the ocean's effects on ASW Systems. "ASW remains the single most urgent problem supported by naval oceanography. Over $96 million, or 47% of the Navy Oceanographic Program supports ASW." [1]

In spite of this stated need for oceanographic knowledge in operational ASW problems, in 1970 the Chief of Naval Operations expressed concern at the failure of the Navy to utilize oceanographic knowledge in this way. [2] In initiating a study into the oceanographic support of ASW, CNO acknowledged the failure of ASW programs to properly utilize: 1) officers who

have gained degrees in oceanography; and 2) an ASW-oriented oceanological support capability. In order to rectify the problems, CNO suggested broadened education for officer specialists/subspecialists or the possible creation of an additional Special Duty Officer category oriented specifically to undersea warfare. Subsequently the Oceanographer of the Navy chaired a study into oceanographic support of ASW, under the direction of VADM Shear's predecessor as Director of ASW Programs, VADM T. F. Caldwell. A summary of the significant data, conclusions and recommendations of this study are included in Appendices C and G.

The data presented in the aforementioned report would certainly justify the concern over the use of officers educated in oceanography. Although relatively few billets exist for officers who have earned degrees in oceanography, it is perhaps more disturbing when one considers the number of these officers who were actually assigned to validated billets for Unrestricted Line Officers (URL-8710P) and Special Duty Officers (1820). Of the fifty-five billets P-coded for URL (8710P), only 25% were occupied by P-coded officers at the time of the Oceanographer's study. At the same time, there were 129 billets for SDO 1820 officers; however, only 72 officers had been selected for this SDO community and 47 of these occupied SDO billets--only 36% of the SDO billets were filled by SDO 1820 officers. [3] As a result of these data and other considerations the Oceanographer of the Navy recommended a review be conducted of billet allocations and assignment policies for these officers.

Several other recent developments would indicate that a great deal of priority is given to the problem of oceanological support and also the use of the support products in the Operating Forces. During 1971: 1) the Oceanographer of the Navy suspended sponsorship of officer education programs in oceanography in civilian universities; 2) almost simultaneously the oceanography curricula at the Naval Postgraduate School were revised at the Navy sponsor's suggestion so that new student inputs in September 1971 have been provided a single, specialized program of environmental study in oceanography and meteorology; and 3) the Superintendent of the Naval Postgraduate School recommended the establishment of a graduate program of study directed toward technical and operational problems of ASW/USW. [4] All of these developments compounded with previous hesitance in the operational utilization of officers who have completed oceanography curricula indicated that further investigation of education and training in oceanography was needed. The lack of sponsorship for any options for oceanography students and heavy concentration on the ocean environment and the prediction of its processes with little emphasis on the systems employed in the environment leaves doubt concerning the applicability of the present curriculum for subspecialists of the Unrestricted Line. Similarly the heavy concentration on physics from the equipment design point of view in the Underwater Physics Curriculum 535 also is not particularly attractive to many aspiring subspecialists. If oceanography is the key to ASW, as VADM Shear has indicated, does the present

curriculum in oceanography offer specialists <u>and</u> subspecialists the best suited education to solve the operational problems of ASW?

It was decided to undertake the present study independently of studies of other groups which are addressing education in ASW and the oceanographic support of ASW. The questions which were to be answered by this study follow: 1) What are the educational and training requirements in oceanography which allow Naval officers to effectively carry out the tasks of billets in ASW and in other Navy applications of oceanography?

2) How might billet allocations and assignments of these officers be designed to allow them to provide effective oceanographic support for ASW and other Navy applications?

This study will attempt to answer these and other related questions by considering the Navy programs in oceanography and their relationship to other national interests. Also, it will consider the interests of the individual officer in a productive, rewarding Navy career.

This study has led to the following conclusions and recommendations:

1) The present organization for providing oceanographic environmental support is somewhat inefficient. The establishment of a Naval Environmental Service consisting of a corps of Special Duty Officers in the Geophysics community (SDO 1810/1820) is recommended. This Service will consolidate the functions of the Naval Weather Service Command and the Naval Oceanographic Office under the Commander of the Naval Environmental Service/Oceanographer of the Navy.

2) In order to provide the full range of education in oceanography and related fields for officers assigned to billets in ASW, R&D, training, and environmental services and other warfare and mission categories of the Navy, a flexible approach to graduate education in oceanography at the Naval Postgraduate School is recommended. Three curricula are recommended to fulfill the special requirements of: a) officers of the URL who desire to become "specialized" in ASW; b) officers who will become a part of the Naval Environmental Service in the SDO 1820 category; and c) officers of the URL who will, as subspecialists, fill project managerial billets involving systems and equipments deployable in the ocean environment.

3) Planned specialization of some air, surface and submarine officers in the warfare subcategory of ASW is recommended. The route to this specialization will build upon experience, training and education to provide a professionally and technically qualified officer to command ASW units at sea and manage ASW programs ashore.

A. STUDY METHODOLOGY

This study was conducted in the following manner:

1. Official U.S. Government, Department of Defense and Navy reports, studies and directives were surveyed as background material relative to the general topic of officer manpower management and education. Several of the studies pertinent to this thesis will be summarized below. Also, studies conducted into ASW problems were examined.

2. In addition to the study of official documents, a survey was

conducted of articles appearing in Navy-sanctioned periodicals and oceanography-related commercial and civilian publications.

3. A brief opinion questionnaire was prepared and forwarded to Naval officers and a few civilian Navy bureau and laboratory employees. The questionnaire, analyzed in Appendix B, was directed primarily to Specialist and Unrestricted Line, Oceanography P-coded attendees of the 8th U.S. Navy Symposium of Military Oceanography held at Monterey, California, 16 - 18 May 1971. This format was modified somewhat and forwarded to several P-coded officers unable to attend the Symposium and to other officers assigned to operational antisubmarine warfare billets.

4. Personal interviews, correspondence, and phone conversations were exchanged with interested officers in Fleet units, training schools and other commands having a mission-related oceanography program.

5. Documents describing assigned missions and tasks of various Navy organizations were studied in order to identify manpower needs where P-coded billets do not presently exist.

6. Existing and proposed oceanography postgraduate curricula at the U.S. Naval Postgraduate School and their relationship to demonstrated Navy-wide officer needs were studied.

7. Data was then assembled to determine how education and training in oceanography might be provided for efficient performance of officers in antisubmarine warfare and other oceanography-related fields in the Navy.

B. DEFINITIONS

Some of the manpower terms used in the following sections are somewhat confusing or may be misinterpreted through their usage. Since their meaning is essential, a glossary of definitions is provided in Appendix A.

C. PREVIOUS STUDIES

As a reflection of the high priority attached to officer education, a number of boards have been convened to study Navy requirements. Although their scope has been considerably more general than that of this study, familiarity with their conclusions and recommendations has been helpful in conducting the present study. Appendix C is a brief summary of pertinent points from seven of these studies.

II. OCEANOGRAPHY IN ASW

In this section the contribution of oceanographic knowledge to the solution of strategic and tactical problems of antisubmarine warfare will be discussed. Oceanography is recognized as only one of many technical areas which are considered in ASW matters. Other areas include electronics, communications theory and electronic signal processing, physical acoustics, systems analysis, human factors engineering, and several other disciplines in engineering.

"Specialization" in the warfare subcategory of ASW will be advocated in which a flexible approach toward career planning is utilized, resulting in an officer who can be considered an ASW expert at the end of his first

12-14 years of commissioned service. This expert status in ASW will be achieved by a logical progression of experience, training and education through "closed-loop detailing." Specialization will consider the total experience of the officer and will build upon the baccalaureate level education possessed upon commissioning. Baccalaureate study in classical fields of science, engineering and mathematics will be rounded-out to include sufficient depth in oceanography and the other contributing disciplines in ASW.

Graduate level education will be recommended to conform to this picture of the developing career in ASW. A prevalent opinion concerning technical graduate education is that it represents study in a narrow field which will enhance the technical performance and promotion opportunity of the officer, but in some respects detracts from his operational performance and requires him to complete "pay-back" shore tours in his technical field which may be detrimental to his career development. In many cases officers have avoided this tour by design as it represents time away from "high-exposure" or career-enhancing shore billets in the career development path in his warfare specialty. Under the concept of "specialization" in ASW proposed herein, graduate education is not only an essential step in the development of his expert rating, but also will help prepare the officer for <u>all</u> future billets within his specialty--whether these billets are ashore or afloat, technical, operational or managerial. Graduate education and the associated P-code will be an essential step in a career of ASW "specialization"; however, specialization will be accomplished under the framework of the Additional Qualification Designation (AQD) in ASW and

the subspecialty P-code will be just one integral step of the more comprehensive AQD ratings achieved.

It will be shown that at the time of selection for postgraduate education, knowledge in oceanography would normally be the technical area most lacking in these officers. There is little opportunity to develop this knowledge through experience and therefore, oceanography will be the normal primary area of graduate level study required to compensate for inadequacies in previous training and experience. The study in oceanography shall be complemented by further study in the other disciplines contributing to ASW expertise.

ASW, like oceanography, is an area which encompasses many disciplines, and which defies identification with a single science or field of technology. It would be simple if ASW were totally electronics and signal processing or oceanography or acoustic engineering, but it simply cannot be so classified. On actual operational situations, if one could terminate all dynamic oceanic processes for a time, it would be possible to apply the contributing scientific and technological factors remaining to achieve a reasonable prediction of the performance of sensors and weapons. In practice, however, it is this dynamic variability of the ocean coupled with ocean features that are relatively unknown which causes ASW to be such a difficult problem for the Navy. Environmental influence is compounded by certain characteristics of our newer acoustic sensors and weapons, whose low frequency, high power and long range capabilities greatly expand the oceanic volume within which these dynamically varying effects are felt.

Furthermore, variability of the ocean's surface and bottom have become important considerations in ASW--in both the strategic and the tactical sense.

In World War II the Navy was concerned with environmental effects on sonar propagation within an envelope extending several thousands of yards in horizontal range and a few hundred feet in depth. ASW forces of today must consider effects on propagation through hundreds of miles in range and to the greatest depths of the oceans. An awareness of the oceanographic factors influencing ASW is achieved by education and training. In order to understand the full implication of these effects on systems, one needs to repeatedly experience them at sea.

A. OCEANOGRAPHIC FACTORS CONSIDERED BY ASW DECISION-MAKERS

It has been stated that "the performance of ASW Systems is controlled by the ocean environment to a greater degree than are other systems employed in naval warfare." [5] Note that this statement acknowledges environmental influence on other systems, but singles out ASW systems as being most affected. Naval warfare is an occupation in which the commander or the operator is continually confronted with decision-making. In antisubmarine warfare, oceanography is the critical or most relevant factor in a great number of decisions such as: "whether to approve the development of a new sonar or ASW missile system; where to install an undersea surveillance system; when to employ one mode of sound propagation rather than another; whether to fire an ASW missile and so on." [5] From the

point of view of the decision-maker, knowledge of oceanography and the effect of the ocean on deployed systems is divided into four areas which must be routinely considered. These are: a) system design, b) system operation, c) system performance and d) system tactical employment. [5]

These are often "life or death" decisions in wartime tactical situations, and in peacetime the proper decision often involves the commitment of millions or billions of dollars in Federal monies. Therefore, it is essential that the decision-maker be either knowledgeable in environmental effects on systems, or at least confident that his advisers are competent in providing this information. Too often costly decisions have been made on the strength of environmental information exclusively or on the strength of hardware information exclusively, with inadequate consideration of the composite picture. [6] In a study conducted for the Chief of Naval Research, the Underwater Sound Advisory group stated:

> "The principal conclusion arising from this study is that many of the important problems in underwater acoustics research involve the environment in a very intimate fashion. Although some progress can be made in understanding the environment by groups having very little interest in acoustics and although there will continue to be immediate sonar needs that can be satisfied by primarily acoustics experiments, future gains by these approaches will be limited. Research in underwater sound must not separate out the 'oceanographic' activity to support it but rather must integrate into itself the knowledge and methods of pertinent parts of oceanography." [6]

Similar conclusions must be made in ASW as in acoustic research. Progress will not be made at a satisfactory rate unless equipment or systems personnel and environmentalists interact in a common goal of ASW operational effectiveness. For the purpose of this study it must be stated that an increased awareness of the influence of oceanography on ASW systems and operations by scientists, engineers, technicians and naval officers is absolutely essential to improved ASW performance. [7]

The effects on oceanographic parameters which influence acoustic systems and weapons performance can be divided for simplicity into four classifications: surface effects, bottom effects, volume effects, and organic effects. [6] The ASW operator should consider all of these effects in planning and executing operations at sea. Even if complete oceanographic outlooks and predictions are provided by the environmental service, it must be understood that these data all involve a certain amount of averaging and hydroclimatology. Consequently, errors of considerable magnitude are possible. Oceanographic parameters should be observed at the scene to determine the fine-scale, local features which will influence acoustic conditions. The operator should be capable of interpreting on board instruments, of interpreting indications on installed sensors, of interpreting visual indications in the environment and of applying meteorological information. When clues provided by these are assembled, a clearer picture of the local acoustic conditions is possible.

The following summary includes many of the factors which must be considered in the tactial application of oceanography to ASW. All have some

effect on sensor or weapon performance. When considering a simple listing such as this it should be reiterated that a very small percentage of the ocean has been surveyed and that nothing approaching synoptic observation of any of these factors is possible on a global or even a regional basis.

1. Surface Effects

Included in the surface effects are: wind, precipitation, evaporation, sea ice, wind waves, swell, entrained gas, tides, insolation, ice melt, sea and land breeze systems and other climatological effects.

2. Volume Effects

Volume effects include the following: turbidity, temperature, pressure, sound speed, sound absorption, internal waves, turbulence, currents, salinity, dissolved oxygen content, river run-off, shipping noise, ice hummocking and breaking, meanders and eddies, upwelling, oceanic fronts, water masses and other hydroclimatological effects.

3. Bottom Effects

Effects related to the ocean bottom include: depth, shape, slope, roughness, shear and bearing strength, stability, acoustic wave propagation parameters, layer structure and parameters, false targets, etc.

4. Organic Effects

Organic effects include not only those organics within the ocean but the human subsystems themselves. How humans perform and how to engineer ASW systems for human operation is a factor which cannot be ignored. Oceanographic organic effects include: the deep scattering layer,

ambient biological noise, sonic marine animals, false targets, reverberation, etc. [6, 8, 9]

5. Variability of Oceanographic Factors in ASW

As was stated above all of these effects, their local rates of variation, and advection have some effect upon acoustical conditions. Consider the plight of the ASW operator at sea. Assuming no radio frequency propagation restrictions are in effect, the ASW task force at sea (including air, surface and submarine units) will receive from the Navy Environmental Data Network summaries of oceanographic and meteorological conditions and predictions of acoustic sensor performance. For this discussion consider the two principal acoustic prediction systems in use at the present time: SHARPS II AND ASRAP II.

SHARPS II (Ship, Helicopter Acoustic Range Prediction System II) provides a computer generated forecast of 50 percent probability of detection ranges for specific sonars, for a 48-hour period. [10] These ranges are based on a thermal structure analysis of an "acoustically homogeneous" SHARPS/ASRAP area of interest in the Northern Hemisphere and the Indian Ocean. The predicted conditions are calculated using sea surface temperature and bathythermograph reports along with hydroclimatological data. Range predictions are computed for all SHARPS/ASRAP areas daily and are provided upon request to ASW commanders at sea in the areas of interest. The expected sonar ranges predicted by SHARPS are those which are typical of the area of interest which is assumed to have a constant mean depth. It is recognized that regions can exist within the predictive area which are

atypical of the whole area. For example, when conditions have established a shallow mixed layer depth the variability from the mean conditions within the SHARPS area will be increased by as much as 50 percent. [10]

ASRAP II (Acoustic Sensor Range Prediction II) is a computer generated range prediction program which is primarily for airborne acoustic sensors. [11] ASRAP provides passive propagation loss profiles and active range predictions for specific sonobuoys in the aforementioned quasi-homogeneous SHARPS/ASRAPS area. As with SHARPS, the accuracy is acknowledged to depend directly upon the number and quality of observations received from the forecast area. The data provided the Operating Forces includes weekly propagation loss profiles for passive sensors and daily active sensor range predictions for each area desired. ASRAP is designed specifically for deep ocean areas and has several significant constraints which are typical of computer models of environmental conditions. The model assumes: 1) propagation loss calculations are based on a plane, flat bottom, and a horizontally homogeneous area. Bottom depth is the mean depth in the ASRAP area; 2) perfect surface reflection is assumed; and 3) no phase reinforcement or cancellation caused by surface or bottom focusing is considered.

Use of the above two prediction systems by the ASW commander is not questioned, and is in fact essential at the present time in determining the optimum employment of his forces in an offensive or defensive ASW role. It is essential, however, to realize what these predictive methods do and do not provide. Fleet Numerical Weather Central, Monterey, first must

have available synoptic bathythermograph observations in the SHARPS/ ASRAP areas. By presenting average conditions over large oceanic areas and using computer modelling techniques which include some qualitative assumptions, significant differences may exist at a given point between predicted and actual acoustical conditions. Local verification and alteration of the predictive techniques to suit observed local conditions are the province of the knowledgeable ASW commander and ASW operator. However, it should not be rashly assumed that a single observation at variance with conditions predicted by ASRAP and SHARPS invalidates the data in predicting mean conditions in an area. [10, 12]

Examples of conditions which might exist to create significant local variation from average predicted conditions can be cited. Since so little of the ocean has actually been surveyed and the predictions are based considerably on hydroclimatological data, significant variation is possible, especially in areas where data is sparse. Local features such as small-scale meanders and eddies from major current systems, internal waves, variation in position of water mass boundaries or oceanic fronts, and especially rapid changes in local weather systems can create large local variations from predicted conditions. Horizontal as well as vertical changes in thermal structure have a significant effect on sonar ranges. [13] Migrating schools of fish and mammals which are not predicted can create significant problems in ASW operations. A recent paper reported unpredicted fluctuation of the depth of the sound-velocity minimum of as much as five hundred meters in a two-hundred mile square area in the vicinity of the Mid-Atlantic

Ridge. [14] Naturally an ASW operator could not know that all of these conditions existed, but he must be aware of their probability and capable of altering tactics when they are recognized to exist by a trained observer.

These represent knowledge of oceanographic effects on ASW which has not previously been adequately provided by training or experience of the operators. And yet possible future operations against a formidable enemy submarine force which is assumed to be capable of exploiting such situations to advantage should give high priority to programs which will develop such oceanographic knowledge in ASW. Mathematical models which have failed to treat environmental variation explicitly cannot hope to account for the significant differences between predicted ASW effectiveness and actual effectiveness. [15]

In peacetime ASW, dramatic exercise-to-exercise, day-to-day and hour-to-hour variation in ASW detection, tracking and kill performance is unaccounted for in theoretical considerations and mathematical models. [16] The dynamic acoustic environment represents the variable which has not been adequately considered in equipment design or by operations analysis personnel.

B. ASW PROBLEMS AND THE ROLE OF KNOWLEDGE OF THE OCEAN

In a recent article in the Naval Institute Proceedings, Dr. Robert R. Mackie, a civilian researcher involved in studies of ASW personnel performance and sonar target classification, made a strong point for the need of ASW specialization by Navy personnel. Dr. Mackie recommended that a

"detailed study should be made of the knowledge and performance requirements of officers with ASW responsibilities in submarines, surface ships, and aircraft with the objective of determining the depth of instruction required for their effective performance in all stated responsibilities." [17] Specialists in ASW who should possess this knowledge will be developed through assignment to a group of interrelated billets ashore and afloat. Dr. Mackie related certain problem areas in ASW which require solution. These problems were stated in general terms and, although a very good exposition of operational problems, they require closer examination. This section will discuss these problems and the application of education and training in oceanography to their solution.

A "highly significant factor influencing the development and retention of ASW operating proficiency during the past 20 years has been the progressive reduction of ASW team training at sea, with friendly submarines as targets." [17] The experience-dependency of the environmental effects on ASW operations cannot be gained by ASW training as presently conceived. The most obvious solution would be to increase ASW training opportunities with actual submarines. Increasing at sea training would certainly improve operational proficiency, but in order to take full advantage of this training competent planning is required so that operators are alerted to environmental conditions and effects. By noting sensor and weapon responses to the varying conditions while employing proper tactical and operational procedures full advantage of ASW training will result.

Education at a level which stimulates and exercises the analytical thought processes of the officer in ASW will assist him to dispense with illogical environmental indications now often assumed, and to focus on the most probable effects of realistic sea conditions on his equipment. Thus knowledge or a thorough appreciation of the environment gained through education can compensate for real operational ASW experience lost through too infrequent exercises.

Many times conditions during staged ASW exercises are such that most of the contributing factors are optimized. This can be extremely harmful. When equipments are properly prepared and operated and sonar propagation conditions are both good and stable, "the ASW/TACCO officer's problem will be largely solved by automatic fire-control equipment and weapon capability. Under these circumstances, the tactical decisions can become almost automatic." [17] It is important that training under these conditions be conducted purely for the sake of training; however, it must be assumed that under wartime conditions an enemy submarine commander will have sufficient environmental knowledge and latitude of mission profile to avoid such ideal conditions and that he will do so. When the submarine commander takes advantage of poor environmental conditions, "the data flow is disrupted, ...the classification is temporarily incorrect", and "communications are imperfect." [17] It is in this situation that "the ability of these (ASW) officers to assess the problem situation and initiate the most appropriate tactical response is a critical, complex skill

for which extensive training is required." [17] If inadequate realistic training is provided, it would seem that education and a great deal of common sense is necessary.

Equipments must be designed and tactically employed with an appreciation of the environmental influences which enhance or degrade performance. Failure to do so results in the type of operational frustration which has historically occurred. "It has rarely proved possible, in practice, to achieve theoretical detection capability or even detection ranges that permit full capitalization on weapons capability. A consequence has been the emphasis on even larger, more complex, more expensive, and more powerful sonar systems." [17] This points up the need for an officer who can fulfill the first critical environmental support function to be discussed in Section III. In the beginning, systems must be designed to operate in the changing environment with a certain flexibility of operation to capitalize on the variable character of the ocean. Paralleling this design approach must be the gathering of pertinent environmental data needed to properly employ complex systems. Sonar equipments have reached a size and complexity which dictates the hull design and size of our ships. It is impractical to change sonars now that whole classes of ships are being constructed about them. Therefore, it is absolutely essential that steps be taken to properly employ present sonars in varying environmental situations. Although in the Fleet since about 1963 and installed in all new destroyer-type ships, it is only in the past two years that a concentrated effort has fully demonstrated the successful employment of the SQS-26 Sonar. [18] Consideration of

environmental effects by the operators has signalled these successes. "The fact of the matter is that the operator has not been shown to be a poor detector; it has simply been shown that rarely has he had sufficient detection experience." Similarly it has not been shown that the equipment is poor equipment. It has simply been shown that rarely has the equipment been employed to advantage in a given environmental situation.

As Admiral Shear has stated, knowledge of the ocean's effects on ASW systems must become "second nature." [1] Future success in ASW will be "directly proportional to our exploitation of oceanography in the solution of our problems." [1] These statements must be fully considered when organizing a curriculum to provide an educational basis upon which officers will build to become technical experts in ASW.

The variability of the environmental influence on underwater sound is the single aspect of the ASW problem which resists quantization. It is an area which requires constant updating and interpretation and therefore is an area which is experience-dependent. This experience can be obtained only through operations at sea, but is enhanced by education and training which provides the requisite knowledge--the whys and wherefores of the ocean environment. The other problems of ASW, such as signal processing, transducer design, and probabalistic studies to determine optimum employment of existing forces, are all quite technical and very difficult problems. These problems must not be disregarded; however, capable civilian scientists, technicians and mathematicians have sufficient grasp of these problems to satisfy the needs for the immediate future. Oceanography (which is a

compilation of data and knowledge about the ocean) represents the area of ASW in which breakthroughs most probably must be achieved. Systems and operations which take advantage of the properties of the ocean are the biggest hopes for improvement in the ASW capabilities of the Navy. In every Navy training school ASW curriculum examined the oceanography/underwater acoustics presentations formed the basis of the course. A similar balance must be attained in the content of a graduate level program aimed at improving ASW capabilities. ASW is conducted at sea in the real environment and therefore the basis of ASW study at the graduate level must be in oceanography.

C. EXISTING BILLETS FOR OFFICER-OCEANOGRAPHERS IN ASW

A great many of the officers who complete curricula in oceanography, have done so in order to more fully understand the ocean and its effects which are felt in antisubmarine warfare. There are now well over 200 URL officers P-coded in oceanography and over 50 SDO 1820 officers who have completed graduate-level study in oceanography. A survey conducted in conjunction with the Oceanographic Support for ASW Study indicated that 50% of those who have completed graduate oceanography curricula had previous ASW/USW experience; 32.4% cited improvement in their ASW/USW proficiency as the principal reason for choosing to study oceanography. [2] This section will examine briefly the ASW billets coded for graduate level oceanographers in the two categories of URL (8710P) and SDO 1820.

1. Unrestricted Line Officers (8710P)

All three warfare categories of the unrestricted line are deeply committed by mission and hardware to antisubmarine warfare. A previous section has identified oceanographic effects on ASW which each officer must consider in decision-making to achieve optimum system performance. For the most part, equipment or hardware has not been discussed. It is felt that in the past this aspect has received emphasis which has been divorced from manning considerations with the result that the human subsystem and his organization has had to adapt to the equipment rather than functioning as an integral part of the system from the outset. The task now, assuming that no significant or revolutionary technological breakthroughs will occur in ASW over the next few years, is to determine the needs in education and training to optimize officer performance with existing equipments.

Present billets for URL oceanographer (8710P) in ASW are very limited in number. Ashore there are several billets which could be classified as technical program managers within the offices of the Oceanographer, the Chief of Naval Operations, the Material Command and within the R&D community. A significant number (25) of the URL 8710P billets are training and education billets at the Naval Academy, at the Fleet ASW Schools and at ASW aviation training sites. A very few officers (9) are involved in P-coded sea billets in ASW. [2] These billets are exclusively at the Destroyer Flotilla or ASW Group Staff level. As the ASW Carriers (CVS) are phased out, several of these billets will be lost.

The latter billets discussed above were created to provide the ASW Commander at sea a staff officer capable of assimilating various environmental data from units at sea and from the Navy Environmental Data Network ashore. The ASWEPS officer would then examine local environmental conditions and generate oceanographic ASW predictions to advise the Commander on the optimum employment of his forces to take full advantage of the existing environmental situation. This officer also supervised the preparation of environmental data for the other surface, submarine and air units of the ASW Task Force. This is the only type of validated billet in which P-coded oceanographers have participated in ASW operations at sea. It is asserted in Appendix F that the numbers of billets for URL (8710P) officers in ASW might not be a true reflection of the contribution these officers are making in that field. Uncoded billets do exist which have benefited from the environmental expertise of incumbents possessing advanced education and/or training.

2. Special Duty Officer, Designator 1820

Officers in the Special Duty Category 1820 are very deeply involved in the support aspects of ASW. A large number (32) of their present billets can be classified as technical management or supervisory positions in the Office of the Oceanographer or the Naval Oceanographic Office and its branch offices. [2] As previously stated these officers manage programs which are roughly 50% (by funding) committed to ASW support. [1] These officers are more nearly under the direct control of the Oceanographer of the Navy (who serves as the sponsor and subspecialty advisor for

oceanography education programs) than any of the officers in the following categories.

The second major category is duty within the organization of the Naval Weather Service Command--the Naval Environmental Data Network. There are presently eleven billets for SDO 1820 officers who are involved primarily with the preparation of environmental (oceanographic) predictions for Fleet ASW units. [2]

There are two other major classifications for SDO 1820 billets in ASW--those involving duties at the Naval Facilities and those entailing duties as instructors. As recommended by the Waters Board (See Appendix C), SDO 1820 billets at the Naval Facilities were included within this category for a special purpose, but they could actually be filled by junior officers of the URL. Education needs for these billets, therefore will not be discussed. There are presently 9 billets for officer instructors at the Naval War College, the Naval Postgraduate School, the U.S. Naval Academy, and Fleet schools in ASW.

The remaining 1820 billets are generally distributed among duties within the R&D community which is heavily committed to ASW programs.

At first glance, it does not appear that the educational requirements for these officers would be common to all categories. However, the small total size of this officer community creates the possibility that any one officer could easily be required to fill billets in each of these categories over his 20 or 30 year career.

Recently, the Navy has been faced with the necessity of decommissioning a number of ASW aircraft carriers (CVS) and the disbanding of the ASW Group Staffs assigned. For this reason the concept of the general purpose aircraft carrier (CV) has evolved. In this concept, fixed and rotary wing ASW aircraft squadrons operate from the attack carriers (CVA) in ASW defense of the task force and in offensive ASW operations. It has therefore become necessary for the carrier staff to provide its pilots not only meteorological data and predictions, but also ASW oceanographic data and predictions. Manning considerations make it impossible to provide both a Meteorologist (SDO 1810) and an Oceanographer (SDO 1820) to the carrier. Consequently, the requirement for a single officer-environmentalist was concluded. This officer is to be fully qualified in either meteorology or oceanography with an adequate basis in the other discipline. The Physical Oceanography and Meteorology curricula, revised in September 1971 to provide a common core for the first three academic quarters and specialization in either Physical Oceanography or Meteorology for the remaining five quarters, were designed to fulfill the educational needs of this "environmentalist."

D. EDUCATION IN OCEANOGRAPHY AND SPECIALIZATION IN ASW

ASW has been called the Navy's number one or number two mission (behind that of our strategic missile submarines) since the ascendancy of the Soviet submarine threat in the Cold War years following World War II. In spite of the priorities attached to ASW and the massive amounts of money

dedicated to development and installation of complex ASW sensors and weapons, the Navy has failed to fully recognize and provide adequately for the unique and continuing need of personnel qualified in ASW. Ironically special recognition and officer qualifications have been provided for warfare subcategories of lesser acknowledged importance such as Electronics Warfare, Special Warfare and Surface Missile Systems. [19, 20] These qualifications do not amount to specialization but do recognize special training and experience required. No similar designation has been available for officers with special qualifications in ASW.

In order to meet the challenge of ASW, it is clear that the Navy must develop officer manpower which can achieve optimum performance at sea with existing sensors, weapons and personnel. This can be achieved through a combination of experience, education and training which will give an ASW officer the needed confidence to exercise professionalism and leadership in ASW. Admiral Zumwalt's policy statement on warfare subcategory specialization outlined in Appendix D would seem to encompass such a degree of specialization in ASW. [21] Career planning is needed to channel officers through repeat tours in ASW billets ashore and afloat in combination with advanced education and Fleet training. RADM E. L. Waller, Commander Fleet Air Wings, Pacific, in a recent address at the Postgraduate School has referred to this concept as "closed-loop detailing." Only through a planned effort in the first 12-14 years of commissioned service will the Navy insure that a true ASW expert will develop who will be capable of performing the complex technical supervision in ASW

management positions ashore and senior command positions in ASW at sea.

To facilitate the identification of officers with special capabilities in ASW an Additional Qualifications Designation (AQD) was developed by the Bureau of Naval Personnel. [22] This AQD provides for the identification of phased qualification steps for officers of all three warfare specialties of the URL from "ASW Qualified" through "ASW Operational Expert" and "ASW Technical Expert." The criteria for this Designation are included in Appendix G. It is strongly recommended that the Bureau of Personnel exercise career planning to insure that those best qualified are channeled into meeting these criteria.

1. Graduate Education for ASW Specialization

On 14 September 1971, the Superintendent of the Naval Postgraduate School, RADM A. S. Goodfellow, recommended the establishment of an officer subspecialty in ASW supported by an ASW Systems advanced degree program at the Postgraduate School. [4] Such a subspecialty would fully recognize the special mix of academic disciplines required to properly manage and operate the complex ASW systems of our ships, submarines and aircraft. Admiral Goodfellow suggested course content which would give students a good academic understanding of ASW systems through study of electronics, acoustics, oceanography and operations analysis. The concept of such an academic program has been approved and a committee at the Postgraduate School is deliberating to determine a curriculum content proposal which will meet the requirements of the sponsor, the ASW Program

Director (OP-095) in the Office of the Chief of Naval Operations.

[23]

To provide the maximum benefit to the officer in ASW, such a curriculum must round out and enrich the officer's knowledge in a manner which cannot be accomplished through other means short of graduate level education. This curriculum must fill in the knowledge gaps left after previous education, training, and experience are considered; and then provide advanced education which will provide for optimum performance in future billets. For a naval officer in ASW this education must enhance future performance both ashore and afloat.

The necessity for oceanographic knowledge was discussed in previous sections. Education in oceanography should dominate in an interdisciplinary curriculum such as RADM Goodfellow has proposed. Naval officers and civilians in the employ of the Navy who have special capabilities in the science of acoustics, the mathematics of operations analysis and the technology of electrical engineering can provide the depth of understanding needed ashore in systems design and the analysis of ASW detection theory. What is needed at sea is an officer who has a good understanding of the theory and design of equipments (and detection and kill models) but who knows well the intricacies of the ocean environment or the real world in which these theories and equipments are applied.

2. Career Pattern of ASW Specialization

The term "specialization" when applied to unrestricted line officers is normally meant to convey that an officer is limited in the performance

of duties to a particular warfare specialty: surface, air or submarine. The traditional concept has been that within this warfare specialty an URL officer ought to be capable of filling any type of billet (with commensurate rank and a certain amount of training and/or experience in advance of his assignment to duties). There are some rather obvious exceptions to this concept, such as duties involving supervision and operation of Navy nuclear power plants. Also, it is not routine for an aviator to transfer from duties as a helicopter pilot to duties as a jet attack aircraft pilot. Further "de facto" specialization does occur by personal choice or in response to the needs of the service in other areas within the warfare specialty of URL officers. According to the Chief of Naval Operations' recent policy statement, an officer's promotion potential must not be jeopardized if he restricts his assignments to a single subcategory in his warfare specialty. Neither should a URL officer whose duties have been extremely varied and general--the classic Navy "generalist"--be at any particular advantage or disadvantage with respect to a URL "specialist" when considering his potential for promotion. An effective leader and manager would be recognized in either case.

In academic and scientific circles with the tremendous expansion of man's knowledge it has become necessary to narrow horizons so that one becomes an expert in a more narrow area of a classical field of study. For example, instead of a classical physicist, it is a sufficient academic or scientific accomplishment to be recognized as a specialist in acoustics or optics with an advanced degree in the traditional degree-area of Physics.

A Mechanical Engineer would consider it sufficiently challenging to devote a life's work to either solid or fluid mechanics or even much more limited areas of concentration which are broadly classified as mechanical engineering.

The Navy, is a reflection of the advanced knowledge in science and technology. In considering a 20 or 30 year Navy career an officer is faced with a conclusion similar to that reached by scientists and academicians. It is simply no longer efficient or logical to sustain the myth in the Navy that all URL officers should maintain a very broad and completely general career pattern.

It is time to recognize and give official approval to planned "specialization" within the subcategories of naval warfare. The subcategory in question here is Antisubmarine Warfare, which is in itself a very broad area. What would specialization of an URL officer in ASW entail?

A graduate level curricula have been proposed for the education of officers who desire to become ASW "experts." However, the Chief of Naval Operations has rejected the concept of restricting the assignment of operational billets in our ASW warships and aircraft squadrons to officers who will have completed the ASW curriculum proposed by the Naval Postgraduate School. [22]

The CNO furthermore recommended against use of any terminology in regard to such a curriculum which would imply that only officers with this subspecialty (P-code) could command ASW ships and aircraft squadrons. [22] Within these guidelines the concept of an interdisciplinary

curriculum at the Postgraduate School "to give officers the combined technical background desired for ASW specialization within the warfare specialities (was considered) highly desirable." [22] The proposed means for accomplishing this specialization was use of the Additional Qualifications Designation (AQD). Official Navy sanction was thereby given to ASW "specialization" by the AQD concept rather than the use of a P-code, but the means for achieving the career planning in the progressive achievement of these ASW Expert ratings was not discussed. This section will outline steps deemed appropriate in achieving this stepped specialization.

It is essential first to promulgate official sanction of ASW specialization to all URL officers, particularly those in officer candidate programs and those assigned to duties in the officer distribution sections of the Bureau of Naval Personnel who have held out against such specialization. Means must be devised to identify early those officers with a particular flair for ASW and who desire to specialize in ASW. It is essential to make this early commitment to ASW and to carefully plan training and education opportunities in order to have an ASW Technical or Operational Expert after 12-14 years of commissioned service who will be especially valuable for the rest of his career in senior management and command categories.

A career pattern will be outlined which will fulfill the qualifications within the Additional Qualifications Designation and take advantage of the graduate level oceanography curricula proposed herein and discussed in detail in Section IV. This pattern will be sketched in a framework which

can be generally applied to URL officers in the three primary warfare specialties. However, it is necessary to point out some essential differences among the warfare specialties with regard to the initial operational phase of commissioned service.

Junior officers in the air and submarine warfare specialties will spend a considerable time after commissioning completing the training requirements of their specialty. Aviators complete flight training requirements which cover roughly two years. The majority of submarine officers will complete a training program of over a year's duration which includes Submarine School and nuclear power training. Therefore, aviators and submariners are provided extensive professional training before they report to an operational unit in their warfare specialty.

Surface warfare officers do not have a comparable training program at the professional level, but will attend courses of shorter duration in preparation for specific billets. The exception is the Naval Destroyer School which provides general professional education in the surface warfare specialty as related to Head of Department duties in Destroyers.

The first 3-5 years of commissioned service is defined as the Primary Operational Phase. In this time the air warfare officer will already have identified his warfare subcategory of specialization by the type of aircraft in which he flies. The submarine officer is specialized in submarines and most are further specialized in nuclear power plant operation. The surface warfare officer is specialized in surface warfare, but could have served in several types of ships and billets.

With these points in mind concerning the first operational tour (3-5 years) of these URL officers, consider the possibilities of planned "specialization" in ASW in the remaining time to the 12th to 14th year of commissioned service. Beyond the first operational tour this framework is proposed for officers of all three warfare specialties. At the completion of the Primary Operational Phase of his career an officer who has performed exceptionally well in ASW duties or who shows promise in this warfare subcategory should be screened and afforded the opportunity to specialize in ASW. By having completed the requisite training courses and an ASW assignment this officer will have achieved the "ASW Qualified" plateau of the AQD in ASW. By his having displayed a particular flair for or a knack in ASW along with general career potential, he should be offered a career-motivating assignment to a graduate level curriculum related to ASW at the Naval Postgraduate School. The curricula as proposed herein in Section IV are recommended.

Following the completion of this curriculum, in which he fulfills the academic requirement of the AQD qualification of "ASW Technical Expert," assignments would follow a sequence of duties at sea and ashore similar to the following:

1) Head of Department, Executive Officer, Tactical Coordinator or staff officer in an ASW-capable ship or squadron. In this billet (regardless of billet title) the ASW specialist would perform the critical function as ASW tactical adviser to the Commander. He would advise him on the optimum deployment of forces, and the optimum employment of sensors

and weapons, with full professional considerations given to all contributing equipment and environmental factors.

2) Instructor in ASW, Project or R&D Manager in ASW Systems, or a billet generally classed as an ASW staff assignment. By experience, education, and seniority, the ASW "specialist" is prepared to serve as an instructor or in a junior management position in ASW programs. He will possess attributes, discussed in Section III, which are so necessary in order to maintain a Navy Shore Establishment which is responsive to the needs of the Fleet. Upon completion of this tour, the officer who had an ASW assignment during his Primary Operational Phase will simultaneously meet the AQD requirements for qualification as "ASW Technical Expert" and "ASW Operational Expert." Furthermore, the objective of qualification by the 12th to 14th year will have been achieved.

The ASW "specialist" in his assignments as a senior officer will be uniquely prepared by education, training, experience and mature expertise. His value will be demonstrated by his grasp of all aspects of ASW including human factors, system design and operation, probabilistic modeling methods and R&D problems. Most importantly this officer has, by his education and experience, gained an appreciation or a "feel" for the influence of the environment on ASW, which infrequent ASW operational opportunities and lack of directed education will deny the "generalist." In his assignments this ASW expert will fulfill two of the three roles discussed in Section III in the concept of optimum environmental support:

1) the enlightened manager in the Shore Establishment who is capable of anticipating the environmental influence upon sensors and weapons under development and of submitting timely requests for environmental data to parallel the R&D effort; and 2) the commander or command adviser at sea who has an appreciation for the environmental influence on sensor and weapon employment and who can enunciate his needs for support products from the Naval Environmental Service.

3. Other Considerations in ASW Specialization

The following items will be briefly stated as areas which merit further study. These should be considered from the point of view of the recognized need for a smaller, higher quality Navy, and the application of these recommendations to specialization in ASW.

a) Q-code ASW billets for junior officers in their first operational tour. Logical candidates for these Q-coded billets would be officers who baccalaureate area of study is one of the areas of concentration in the graduate curriculum proposed in ASW Systems.

b) Provide a flexible framework of study in the proposed ASW Systems curriculum. This flexibility will permit validation of prerequisites which have been completed at the baccalaureate level and the substitution of more advanced courses. The result will be a more efficient use of time by the officer and a superior product possessing a higher level of education.

c) Validate the need for a graduate of the ASW Systems or Oceanography-ASW curriculum in every principal operational-level ASW organization (i.e., SQS-26 ships; VP, VS, and HS squadrons; ASW Groups, etc.). Since the

actual billet this individual fills is immaterial, it is suggested that the most logical approach would be the utilization of the B-code. The B-code indicates the validation of need for graduate level education in accordance with DOD policies, but acknowledges an inadequate supply of qualified individuals. Procedures should be established wherein several billets of appropriate seniority are B-coded in each ASW command and at least one of these billets is filled by a qualified officer as resources are available. For example, B-code the Weapons Officer, Operations Officer and Executive Officer billets of DE-1052 Class Destroyer Escorts for graduates of the ASW-oriented graduate curricula "Oceanography-ASW" or "Oceanography-Acoustics." In the interim, it is suggested that URL officers P-coded 8710 be assigned to these billets.

d) Take immediate steps to stabilize crews of ASW units for a complete operational cycle of the unit.

e) The Naval Postgraduate BS/BA Curricula have recently been opened to Commissioned Warrant Officers and Limited Duty Officers. Select younger and more promising officers in these two categories who have had experience in ASW/USW technical rates to attend a baccalaureate level oceanography curriculum. This education will expand and round-out their capabilities as a counterpart for the URL ASW "specialist." These officers would be of great value as technical managers in ASW both at sea and ashore.

f) The recent Oceanographic Support Study for ASW recommended expansion of Fleet ASW school curricula to include more engineering, equipment design and environmental instruction. Assuming no expansion of curriculum

lengths, this is not a feasible solution. Present courses represent tradeoffs among the numerous topics and would require greater course duration to accomplish more. The adoption of ASW specialization, ASW-oriented graduate curricula, "closed-loop detailing," and the other steps outlined above would mitigate the need to expand Fleet ASW school curricula, and thus the need for improvement in the general level of expertise in ASW implied in the Oceanographic Support Study would be readily accomplished.

III. OCEANOGRAPHIC EDUCATION IN OTHER NAVAL APPLICATIONS

A study has been conducted into the content and extent of the Navy's participation in scientific and technological programs in the oceans. These Navy Oceanographic Programs are summarized in Appendix F. Further, since Navy programs are becoming more coordinated with overall civil programs, the overall National Programs in oceanography, marine science and technology have been summarized in Appendix E. In considering education and training requirements of officers assigned to billets in these programs it was necessary to investigate the policies which guide the Navy in establishing education and training and in granting quotas in funded education programs. These policies have been summarized in Appendix D. Appendix G summarizes existing officer education and training curricula in oceanography and the utilization of officers subsequent to their completion of advanced education programs.

This section will summarize the education in oceanography required by officers for duties other than in the warfare subcategory "specialty" of ASW. Requisite education will be discussed for billets within the Naval Oceanographic Programs which includes Naval officers assigned to duties in the Department of Defense, the Navy Department, the Office of the Chief of Naval Operations, the Naval Material Command and subordinate Systems Commands and laboratories and the Office of the Oceanographer of the Navy and his Assistants.

A. THE CONCEPT OF OPTIMUM ENVIRONMENTAL SUPPORT

In order for timely and accurate environmental support to be provided for the Navy Operating Forces at sea, a three-pronged effort is necessary. The three types of officers involved might be designated as a) the technical officer, b) the environmentalist and c) the fleet operator. This effort begins essentially in the conceptual stages of a new system or weapon and progresses through its tactical or operational employment at sea.

The earliest requirement for environmental support arises because of possible environmental influence upon a proposed sensor or a weapon or other system or structure which is deployable in the ocean. This aspect requires personnel in the technical Systems Commands and the various laboratories of the Material Command to have sufficient environmental expertise to anticipate effects on systems and further to intelligently request the gathering of appropriate environmental data from Navy

environmental commands. "Investigation of environmental complexities must proceed hand-in-hand with the systems through development." [7]

Hence, the first effort entails a "technical officer," with expertise in environmental matters. This need remains through system development, operational testing and Fleet introduction.

The second aspect of environmental support is the necessity of having an environmental corps of officers who are capable of interacting effectively with the Operating Forces and the technical Systems Commands and laboratories within the Navy Material Command. These officers must be completely competent within their environmental specialty area but further must be able to anticipate the environmental needs of technical development projects ashore and be familiar enough with operations at sea to point out forcefully the environmental needs of the on-scene commander. This Navy "environmentalist" must be a trusted adviser of both technical project managers and Fleet operators.

It is believed that the third contributor to effective fleet environmental support has often been the "weak-link." This is the "Fleet operator" who must have sufficient environmental expertise to augment his technical and tactical abilities in order to properly anticipate and enunciate his environmental needs through the proper channels. He must be familiar with the environmental effects upon his systems and weapons and must insist upon data, which is both timely and accurate, in a format which is operationally useful.

It is believed that proper billet allocation and education within the Navy system of specialists and subspecialists can prove the concept of three types to be effective. The subspecialist "Fleet operator" is the seagoing element of the triumvirate of environmental support. He possesses the essential mix of operational, technical and environmental experiences, education and training for on-scene effectiveness. "The officer who is familiar with equipment capabilities and limitations in its operating environment, who understands the underlying principles of its design and who knows what standards of performance and reliability can be achieved inevitably will have considerable influence on the development of new weapons systems." [24] The "technical officer" in management can be either a specialist or a subspecialist in the technical area of his billet; however, it is essential that he possess this "environmental awareness" whether it be achieved by training, education or experience. The "environmentalist" should be a specialist, but as such must be afforded the opportunity to observe and obtain considerable expertise in the operational application of the data provided by his environmental service command. It is therefore essential that billets be established for environmental specialists on operational staffs at sea. Furthermore, these operational assignments should come early in his career so that a true understanding of his need is not achieved by the "environmentalist" beyond the point at which his talents are applied to purely managerial or administrative functions.

For optimum environmental support the Navy must also correct a fundamental weakness in the provision of environmental services to Navy

users. Simply stated, the problem is this: The Navy operates in the total three-dimensional oceanic environment with surface, subsurface and air forces. An understanding of the dynamics of this environment cannot be isolated into either meteorological or oceanographic studies with no recognition of the intimate effects at the interface. Neither can the division of organization continue with one group principally interested in the environment from the interface outward and the other group from the interface inward. The Naval Weather Service Command is an organization consisting primarily of meteorologists who are more responsive to the needs of the aviation branch of the Navy, although tasked with providing prediction services for the total environment. The Naval Oceanographic Office consists primarily of oceanographers, geodesists, and hydrographers who are more responsive to the surface and submarine branches, though tasked with provision of charts and aids for the total environment. Significant efforts have been made toward unifying and coordinating the total oceanic environmental effort. Perhaps the most significant was the grouping of officer specialist (SDO) oceanographers, meteorologists and hydrographers into the Geophysics community (18XX). Other steps include the assignment of the Commander Naval Weather Service Command as Assistant Oceanographer for Environmental Predictions; and the establishment of common instruction for the first three academic quarters in the Environmental Science Curricula (Meteorology and Oceanography) at the Naval Postgraduate School.

It is believed that these steps are indicative of a trend which should lead to the eventual establishment of the Naval Environmental Service. This Service would encompass all operational functions of the Naval Oceanographic Office and the Naval Weather Service Command. In the interest of efficient coordination of environmental effort and resources it is recommended that consideration be given to this merger. The establishment of the Naval Environmental Service would serve to focus the requirements for the education of specialist oceanographers of SDO 1820.

B. EDUCATION IN OCEANOGRAPHY FOR THE R&D MANAGER

With the present total of only 12 billets for officers of the URL (8710P) and SDO 1820 in research, development, test and evaluation, a serious probability exists that there is inadequate direction of effort toward fulfilling Fleet mission area and warfare needs in oceanography. [2] This is a serious charge and one which requires analysis beyond the scope of the present study.

A recent study of R&D administration in civilian corporations has arrived at some conclusions which are relevant to this charge. In this study it was concluded that the administrative activities of the research administrator "require specialized education, long experience, or both" and that ideally the administrator should possess both. [25] Furthermore,

> "to some extent academic training is a substitute for experience. But it is not and never will be a substitute for the skills and common sense developed through experience. Only by solving real problems can a man develop the sensitivities that enable him to see beyond the obvious so that he can learn to make sound decisions." [25]

Research administrators in Navy R&D activities must have full authority to carry out the efforts of their individual laboratories. Continuity in research administration is quite naturally provided by the civilian directors of research who must be capable both in their field of science, engineering or technology, and in administrative functions. The element which can potentially weaken the system is the Naval officer-manager who provides the military supervision and direction to the civilian researcher. It is this individual who provides the proper orientation of effort, by being not only academically competent, but also by being capable of relating the needs of the Fleet to R&D efforts which are within his purview. Again it is appropriate to relate conclusions of the corporate R&D administration study which are applicable.

> "What is needed and what demonstrably pays off for companies that use research most successfully is the ability of managers to help research specialists understand the company's needs and the ability of researchers to give management a grasp of the technical problems and probabilities involved in specific ventures. On both sides, the ability to determine priorities is a key to success in what is widely recognized as one of the most speculative fields of human endeavor (R&D)." [25]

The company in question is, of course, the Navy. The problem is to determine what education and experience is necessary for the military R&D manager in the Naval Oceanographic Programs and how it is to be provided.

The relationship to the current and projected Navy needs which must guide research is lost when naval officers are permitted to participate directly in research projects for long periods of time. In order to maintain this all-important relationship, naval officers with the requisite technical

education and recent experience in operational mission and warfare areas must be rotated at intervals through these R&D supervisorial billets. The actual scientific and technical research must remain the purview of skilled civilian employees.

In order to provide capable military supervision of the R&D efforts of the Naval Oceanographic Program: 1) Billets must exist for properly prepared "officer-oceanographers," 2) "Officer-oceanographers" must be afforded the proper education and experience to meet the needs of providing Fleet-orientation of these R&D billets and 3) Billets must be filled by qualified "officer-oceanographers."

A certain priority should be attached to the provision of proper military R&D managers. Not only is the Navy becoming more compact, but also a trend has developed which necessitates that more of the research and education activities be performed by Navy in-house schools and laboratories. Militant civilian activists demonstrating against the professional military services, along with budget constraints have caused not only the suspension of some academic programs for Naval officers in civilian universities, but also the termination of some defense-oriented research programs in civilian laboratories and institutions. Military R&D funding limitations have made it essential that Navy R&D activities make an early determination of those development projects which do not show promise and establish priorities among those which do. Pertinence to Fleet needs and applications must be the essential criterion.

C. EDUCATION FOR THE NAVAL OCEANOGRAPHIC PROGRAMS

Previous paragraphs in this Section have outlined some philosophical guidelines chosen to assist in identification of the oceanographic knowledge which officers in the Naval Oceanographic Programs must possess.

It must be recognized that the current allocation of billets for specialists and subspecialists does not necessarily represent that which will exist ten years hence. Neither can any new oceanography curriculum expect to fulfill all of the academic needs of these officers ten years hence. Speculation is involved; however, management systems have been established to update the Future Professional Manpower Requirements Study (summarized in Appendix C) periodically with the best projections of need. These projections in the area of oceanography and ocean engineering show significant growth in numbers of officers required.

In following the development of the curricula in oceanography within the Environmental Science Programs of the Naval Postgraduate School it is obvious that there has been vacillation in regard to the Sponsor's requirements. As outlined in Appendix F, the oceanography education provided has gone through five phases as follows: a) a few courses in oceanography within the Meteorology curricula; b) an Air-Ocean Environment curriculum with equal emphasis on oceanography and meteorology; c) establishment of a separate curriculum in Physical Oceanography followed by the establishment of a Department of Oceanography; d) the offering of a trial curriculum in Ocean Technology aimed toward officers who

would gain graduate level knowledge in technical fields and in the ocean environment and would thus be capable technical project managers within the Naval Oceanographic Program; and e) the recent return to a curriculum which provides a solid environmental knowledge in both oceanography and meteorology. Questions which must be answered are these: Does this shifting emphasis in oceanographic education reflect changes in the knowledge required for the billets officers must fill or does it simply represent changing emphasis by successive administrators who sponsor the curricula? Is it possible that there is a need for officers with a variety of educational credentials in the broad field of oceanography which is largely unfulfilled when the sponsor chooses to emphasize one particular curriculum? Should graduate education in oceanography be more comprehensive, allowing training and experience to fulfill the specific requirements of a billet?

For the purpose of this study it is assumed that two significant steps will be taken in the near future which will influence curriculum-choice in oceanography. These are the establishment of a Naval Environmental Service consisting primarily of specialists in the Geophysics category (18XX); and the recognition of specialization in the warfare subcategory of ASW.

These two developments will more clearly point out the oceanographic education requirements of these officer groups. The education which must be provided by the Naval Postgraduate School is based upon the above assumptions and analysis of the Naval Oceanographic Programs (Appendix F).

The following options in oceanography graduate curricula are indicated: 1) a curriculum option for the environmental specialist who will be required to gather data and provide environmental analysis and predictions. The specialist will also administer programs which include Ocean Science, Oceanographic Operations and Environmental Prediction Services; 2) a curriculum option in ASW ("Oceanography-Acoustics"), for subspecialists of the URL. This option will provide for the educational needs of subspecialists who participate in ASW-related portions of the Naval Oceanographic Programs; 3) a curriculum option of technical education ("Ocean Technology") for subspecialists of the URL. This option will provide requisite environmental and technical knowledge for subspecialists who will act as R&D managers and project officers of programs in the Navy laboratories, the Systems Commands and other activities of the Navy and Defense Departments. These include Ocean Engineering and Development Programs under The Chief of Naval Development (Deep Submergence and Deep Ocean Technology).

1. Education for Environmental Specialists

As presently conceived, SDO 1820 officers may be assigned to billets in the general areas of: research and development; oceanographic forecasting; mapping, charting and geodesy; administration of Naval Oceanographic Programs; antisubmarine warfare program planning; or as instructors; or as Commanding Officers and Executive Officers of Oceanographic Detachments in USNS Ships. To develop the level of expertise needed for these duties, experience, training and education all must be considered.

The area of mapping, charting and geodesy; and the billets as Commanding Officer/Executive Officer of Oceanographic Units are considered hyrography or joint hydrography-oceanography billets. The remaining areas have educational requirements similar to those of billets which are also filled by subspecialists. The difference, it seems, is one of depth. The subspecialist must be capable of applying knowledge of environmental conditions to the optimum operation of complex equipments and impart this sea-going experience in P-coded billets ashore. The specialist must be capable of an in-depth understanding of the environment and of providing aid in its interpretation to the Fleet operator. The educational needs for specialists include broad study in oceanography, synoptic prediction techniques, meteorological/oceanographic inter-relationships, and modeling techniques using computers. Experience gained by rotation in the areas of specialization will provide the specialist with the capability to carry out the management tasks in R&D and program administration.

2. Education for URL Subspecialists

In the previous section on R&D management the critical need for relevancy in the R&D community was pointed out. The officer with recent operational experience is essential for maintaining this relevance or Fleet orientation to these R&D activities. Within the Naval Oceanographic Program a number of laboratories, the Systems Commands, the Naval Material Command and the organization of the Chief of Naval Research are all involved in performing R&D related to the ocean environment. At the operational level, R&D and operational test and evaluation of new

equipments and systems requires officers possessing knowledge of environmental effects. Ocean Engineering, which relates the special influences of the ocean in traditional fields of engineering and technology, has been recognized as an emerging field of interest to the Navy. The programs of the Assistant Oceanographer for Ocean Engineering and Development encompass most of the Navy programs in this field. However, at the present time, graduate level education requirements in ocean engineering have been identified only for Engineering Duty Officers (1400) and Civil Engineer Corps Officers. There are a number of fields which may loosely be assembled under the name "Ocean Engineering," such as diving technology, dynamic effects on ocean structures and vessels, deep ocean construction and physical properties of sediments, salvage, search, rescue and recovery. That many of these fields support naval warfare and mission areas is obvious, and it is hereby asserted that the use of URL officers as Fleet-oriented R&D managers in these areas is equally obvious. Within the general classification of Ocean Engineering or Applied Ocean Science there is a need for several areas of subspecialization. In order to analyze these officer educational requirements, the programs of the R&D activities are summarized in Appendix F. Based upon these programs the areas of academic concentration for officers assigned to a management or project officer billet in these activities are identified and summarized in Table I below.

Table I. Academic Areas of Concentration in "Ocean Technology" for R&D Managers

LABORATORY OR R&D SITE	OCEANOGRAPHY OPTION INDICATED
Naval Research Laboratory	ASW Oceanography General Oceanography Marine Acoustics Ocean Engineering Marine Biology
Naval Oceanographic Office	ASW Oceanography General Oceanography Hydrographic Engineering Marine Geophysics
Naval Undersea R&D Center (all sites)	ASW Oceanography General Oceanography Marine Acoustics Ocean Engineering Marine Biology
Naval Underwater Systems Center (Newport and New London)	ASW Oceanography Marine Acoustics Ocean Engineering Marine Geophysics
Naval Civil Engineering Laboratory	Ocean Engineering
Naval Ships R&D Center (Carderock and Panama City)	Ocean Engineering
Naval Air Development Center	General Oceanography Marine Acoustics
Naval Ordnance Laboratory	General Oceanography Marine Acoustics
Naval Postgraduate School	ASW Oceanography General Oceanography Marine Geophysics
Operational Test and Evaluation Force (Norfolk and San Diego)	ASW Oceanography Marine Acoustics

LABORATORY OR R&D SITE	OCEANOGRAPHY OPTION INDICATED
Submarine Development Group One	ASW Oceanography Marine Acoustics Ocean Engineering
Submarine Development Group Two	ASW Oceanography Marine Acoustics
Destroyer Development Group	ASW Oceanography Marine Acoustics

This summary will guide the choice of oceanography curricula for subspecialists discussed in the next section.

IV. RECOMMENDED OFFICER EDUCATION AND TRAINING IN OCEANOGRAPHY

It has been established that three basic options in oceanography all having a common core of basic subject matter, will provide the requisite knowledge for environmental specialists, ASW "specialists" and subspecialist oceanographers. In this section curricula recommendations will be offered which provide the special knowledge required for the professional performance of these three groups of officers in future assignments.

It is assumed that these officers will be assigned to validated billets in their specialty or subspecialty area and, through feedback, the curricula will be updated to provide the proper course content. Effective feedback requires that the validated billets in oceanography be filled. As shown in Section I only a relatively small percentage of these billets were filled by officers with the requisite P-code in mid-1971.

Two recommendations for officer training in oceanography will be discussed. This training is expected to improve the general level of oceanographic knowledge of officers in the Operating forces.

A. SPONSORSHIP OF OCEANOGRAPHY OPTIONS

The requirements for a Master of Science in Oceanography are specified in Appendix G. If only the minimum time requirements for prerequisites and the degree (35 quarter-hours of graduate level oceanography and an acceptable thesis) are met, it is seen that in a two-year curriculum considerable flexibility is possible. For example, if one assumes that 25 quarter-hours of prerequisites are necessary--when added to the degree requirements (35 hours), between 50 and 60 additional quarter-hours of instruction may be provided in an average two-year curriculum.

At the present time a single oceanography curriculum is available for new students at the Naval Postgraduate School (excluding IGEP's). This curriculum will not provide the academic credentials for all present and conceived billets. The Physical Oceanography Curriculum 440, as revised in September 1971 is designed to fulfill the academic needs of a corps of "environmentalists." This intensity of concentration upon the environment (air and ocean) does meet the requirements of oceanography specialists (SDO 1820); however, sufficient coverage of other topics in science and engineering is not provided to meet the established needs of subspecialists.

As curriculum sponsor, the Oceanographer of the Navy is in a peculiar position. Although tasked with sponsorship and acting as the subspecialty

adviser, the Oceanographer exercises direct organizational control over few of the billets P-coded in oceanography. Only 39 billets (15 are 8710P) for specialist oceanographers and 3 billets for subspecialists (URL 8710P) are on the staff of the Oceanographer of the Navy and in the Naval Oceanographic Office. All other officers in this community are in billets in separately-constituted commands. Some billets are within the organizations of the Assistant Oceanographers, but the Assistants perform other major functions such that their Naval Oceanographic Programs are only a part of their total function. In fulfilling his assignment as curriculum sponsor and subspecialty adviser, the Oceanographer must correlate the academic needs of his own staffs, and of officers outside his control who are applying knowledge in oceanography to problems in R&D, Education and Training, Intelligence, Environmental Prediction, as well as in uncoded assignments in warfare and mission areas throughout the Navy.

This study has concluded that three basic options in oceanography graduate level education are necessary. If these options are accepted the Oceanographer might consider sponsorship arrangements as follows:

1. The Oceanographer might continue as sponsor for all options--correlating the specific requirements of divisions within the Naval Oceanographic Program and the Operating Forces.

2. The Oceanographer might continue as sponsor of the curriculum for "environmentalists" and assign other commanders as sponsors for

specific degree options which fulfill the educational requirements for officers within their organizations.

The former arrangement is still preferable since confusion will be more easily avoided. More importantly, since the Oceanographer is directly under the Office of the Chief of Naval Operations, he is in a position to make forceful recommendations to CNO concerning oceanographic knowledge required in the warfare and mission areas supported by the Naval Oceanographic Program. These include: strategic warfare, surveillance, striking force operations, amphibious warfare, mining and mine counter-measures, navigation, reconnaissance, intelligence, search, rescue, salvage; and especially antisubmarine and undersea warfare.

A possible exception to sponsorship by the Oceanographer is the curriculum under development at the Post graduate School for ASW education. This curriculum will be sponsored by the Director, ASW Programs (OP-095). [24]

B. THE NAVAL POSTGRADUATE SCHOOL IN OCEANOGRAPHY EDUCATION

The Naval Postgraduate School initiated a study in 1967 leading to the submission of the "Five-Year Development Plan in the Ocean Sciences." [26] For evaluation of this plan an advisory committee with very distinguished credentials was convened from outside the Postgraduate School organization to make further recommendations concerning Ocean Science Programs.

The advisory committee was chaired by Dr. Arthur E. Maxwell, of Woods Hole Oceanographic Institution, and included members actively

involved in marine programs. The committee of five members included an engineer, an acoustician, a Navy R&D program administrator and an oceanographer, in addition to Dr. Maxwell, a physicist. Significant comments and recommendations of the committee regarding the organization of the Ocean Science Program at the Postgraduate School follow:

a) "Some assessment must be made of the needs for officers with graduate training in the field (of Ocean Science) who will ultimately be assigned responsibilities in ocean forecasting, underwater surveillance, special vehicle design, ocean engineering, weapon design and operation, special ocean project management, R&D Labs, etc." [26]

b) The director of the Ocean Science Program encompassing the Department of Oceanography and with strong contributions from the classical departments such as Meteorology, Physics, Chemistry, Electronics, Mechanical Engineering and Civil Engineering, should be a distinguished scientist responsible directly to the Dean of Research and the Academic Dean. If the Ocean Science Programs were organized thusly an aggressive and responsive program would be assured.

c) Ocean Science Programs should include the Meteorology, Oceanography and Underwater Physics curricula as well as other recommended, related curricula such as Underwater Corrosion, Ocean Engineering, etc.

d) The principal shortcoming of the underwater physics curriculum (535) was the "lack of wide enough exposure to knowledge about the nature of the real world". [26]

e) The goal of Ocean Science curricula should be to provide "officers who can appreciate the significance of the interactions between the marine environment and system effectiveness". Curricula then existing (Meterorology, Oceanography, and Underwater Physics) needed "more emphasis on basis design principles underlying types of systems whose performance graduates will predict." [26]

f) The committee endorsed the concept of a proposed Applied Ocean Science curriculum and stated its goal should be to give officers the "ability to analyze potential performance of proposed systems or to be able to understand the performance of systems in being, as used in the world of real operations and real environmental conditions." [26] This curriculum should include topics in oceanography, underwater physics, electrical and mechanical engineering, and operations analysis.

These comments are still valid and the recommendations concerning the content of the Applied Science Curriculum and the organization of the Ocean Science Programs are pertinent to the present discussion. These points should be examined in light of the educational needs identified by this study and the recommendations made by the Postgraduate School regarding the establishment of an ASW Systems Curriculum. [4] The program recommended by RADM Goodfellow would appear entirely in line with the broad objectives of the Applied Ocean Science curriculum considered and endorsed by the 1967 Advisory Committee. However, instead of the broad term "systems" used by the Advisory Committee the emphasis is placed upon ASW systems.

A committee at the Postgraduate School is deliberating on the content and organization of the proposed ASW Systems curriculum, but several difficult problems remain unresolved at this time. It is believed that the recommendations of the 1967 Advisory Committee offer at least a partial solution to these problems.

Problems with an ASW Systems Curriculum are specifically: a) Identification of the requisite mix of academic courses to fulfill the needs of officers whose subspecialty following graduate study will be ASW. Academically, what is ASW? b) Identification of the "parent" academic department or other administrative unit to supervise the academic interdepartmental functions of this curriculum; c) Establishment of an interdisciplinary curriculum capable of fulfilling accreditation requirements in a recognized graduate academic discipline.

In Section II, it was demonstrated that the environmental influence was the single least-understood and least-anticipated variable in the ASW problem. This influence historically has received inadequate consideration in the design of ASW systems, and ASW operators rarely achieve a sufficient level of expertise in the purely technical facets of equipment operation, maintenance and tactics to consider the environmental effects in other than a cursory manner. It has been concluded that ASW "specialization" as outlined in Section II is essential. Furthermore, the environmental knowledge must form the core of a graduate level academic program in ASW (or Applied Ocean Science).

It is important that a graduate program directed toward ASW be interdisciplinary rather than nondisciplinary. The full strength of each of the contributing disciplines is needed. Only by fully utilizing faculty resources, the facilities of the various participating departments, the ready access to latest developments in the various disciplines, the contacts of those disciplinary groups with specialists around the country and in the Navy, will an ASW program succeed. Admiral Shear implied that such a program should not be set up independently when he advised that the title "ASW" should not be used for the program, except as a modifier. [23] Previous experience at NPS with the computer science and engineering-acoustics programs has demonstrated the difficulties of operation by committee of independent departments.

For a good ASW/educational program, as for any successful program, clear leadership and a definite "lead agency" is needed. ASW operational decisions cannot be made by committee--neither can a program to educate men who will make such decisions be directed by committee. Further, the director of such an educational program must be associated with and clearly recognized in one of the contributing disciplines. He must have an interest in ASW problems and a knowledge of them. Therefore, long years of association with ASW problems and the men involved in solving them is essential.

The "lead agency" at the Naval Postgraduate School should be one of its fully established and generally recognized educational units, namely an academic department. This unit must serve as a home base for the

students who will study in the ASW curriculum and for the faculty who will teach that portion of the subject matter. It must be the administrative unit which sends the students to complete the needed studies in other departments as advised by an interdepartmental group. It is recommended that the "lead" academic department for the ASW curriculum proposed by RADM Goodfellow should be the Department of Oceanography.

Assignment of the Department of Oceanography as the "parent" academic department will alleviate the problem of identifying a recognized discipline in which to award the Master of Science degree. As a further consideration, it is believed that faculty members would be hesitant to commit themselves to a program which does not allow them to maintain association with a recognized graduate discipline. This is particularly the case at this time when academic employment is apparently so competitive. Any graduate program in ASW must remain "education" rather than degrading to "training" or it will not be attractive to either student or faculty.

C. RECOMMENDED EDUCATION AND TRAINING IN ASW OCEANOGRAPHY

In Section II, the inescapable contribution and importance of oceanographic knowledge in ASW was discussed. A basic foundation of graduate level study in oceanography was advocated for the ASW "specialist" to compensate for deficiencies in training and experience. Beyond the necessary study of oceanography a certain amount of flexibility is needed to allow for previous academic attainment of incoming students.

The Director of ASW Programs, VADM Shear, has committed his office as sponsor for an ASW curriculum similar to that proposed by RADM Goodfellow. [23] However, he has proposed that several different curriculum titles might be considered--including "Oceanography (ASW option)."

The object of this curriculum is clearly the URL officer who will rotate between ASW operational tours at sea and ASW managerial tours ashore. Assignment to this curriculum will normally represent the only opportunity for graduate level technical education for an URL officer. Therefore, the goal should be to provide a broad technical base in the disciplines of ASW which will allow for future career development. Courses which will lead to an understanding of the ASW environment, the ASW system design considerations and the ASW system operational employment should be provided. This understanding will be provided by the mix of courses in the "Oceanography-ASW" curriculum proposed hereafter.

Since the support role of oceanography is so significant in the design and employment of ASW systems, the Oceanographer of the Navy needs to maintain a Fleet currency in ASW within the programs he directs. This can be provided by SDO specialist oceanographers who return from ASW operational support tours at sea to duty within the Naval Oceanography Programs, and subspecialists who have recently served in ASW operational billets. In billets of the Naval Oceanographic Programs these URL officers will require a fuller understanding of purely environmental and environmental acoustics topics, than of systems topics. Therefore, a slightly

modified program is appropriate to include emphasis on oceanography and underwater acoustics. Such a curriculum is hereby recommended to be called "Oceanography-Acoustics" and to be sponsored by the Oceanographer of the Navy.

Two ASW curricula will therefore be recommended--one sponsored by OP-095 and the other by OCEANAV. Both will result in the awarding of the Master of Science in Oceanography. Furthermore, both curricula would also satisfy the technical degree requirement for qualification as an "ASW Technical Expert" under the AQD in ASW, and will provide some flexibility to allow validation of previous academic attainment of officers in the disciplines involved.

The curriculum sponsored by the Oceanographer of the Navy ("Oceanography-Acoustics") should be essentially a strong major in physical and descriptive oceanography with a minor in underwater acoustics. The "Oceanography-ASW" curriculum which will be sponsored by the Director, ASW Programs will provide the minimum requirements for a Master of Science in Oceanography and offer sister-fields in electronics, probability and statistics, operations analysis and underwater acoustics. Since Oceanography is recognized as a developing field both in and out of the Navy, the awarding of the MS in Oceanography will provide the much-needed motivation for officers to request this curriculum.

1. <u>The Oceanography-ASW Curriculum</u>

Figure 1 is the curriculum recommended to fulfill the academic

requirements for a more effective ASW operator at sea and a more competent ASW program administrator ashore.

Figure 1. Proposed Oceanography-ASW Curriculum

Sponsor: Director of ASW Programs (OP-095)

Subspecialty Adviser: Director of ASW Programs (OP-095)

Recommended Product: URL (8711P)

Prerequisites, Degree and Departmental Requirements	Quarter Hours
1. Mathematics	
Linear Algebra/Vector Analysis	4.0
Differential Equations	4.0
Partial Differential Equations	4.0
Introduction to Mathematical Physics	4.0
Complex Variables	4.0
	20.0
2. Electrical Engineering	
Principles of Electrical Engineering	4.0
Electronic Engineering Fundamentals	5.0
Communication Theory	4.0
	13.0
3. Physics	
Review of Vector Mechanics and Optics	5.0
Mechanics I	4.0
	9.0
4. Oceanography	
a) General Oceanography	
Descriptive Physical Oceanography	4.0
Geological Oceanography	4.5
Biological Oceanography	4.5
Chemical Oceanography	4.0
Scientific Cruise Experience	2.0
	19.0

b) Graduate Oceanography	Quarter Hours
Dynamical Oceanography	4.0
Waves and Tides	4.0
Coastal Oceanography	4.5
Seminar in Oceanography	2.0
	14.5

Sponsor Requirements

1. Physics

Fundamental Acoustics	4.5
Underwater Acoustics	5.0
Propagation of Waves in Fluids	4.0
Advanced Acoustics Laboratory	1.5
	15.0

2. Oceanography

Oceanographic Forecasting	3.0
Oceanographic Forecasting Laboratory	2.0
*Geophysics--Sound and Seismicity	4.0
	9.0

3. Probability and Statistics

Probability Theory I	4.0

4. Operations Analysis

Search Theory and Detection	4.0

5. Electrical Engineering

Statistical Communication Theory	4.0
Signal Processing	3.5
Underwater Acoustic Systems Engineering	5.0
	12.5

Summary

Prerequisite, Degree and Departmental Requirements	75.5
Sponsor Requirements	44.5
Curriculum Total	120.0

* Indicates 4000 Level Degree Requirement

Degree Requirements (Oceanography)

3000-4000 Level	4000 Level
40.5 (35 Required)	18.5 (15 Required)

A graduate level curriculum of 120 quarter-hours in eight quarters represents a quite heavy, though not unmanageable, course load for students. The following recommendation is made, partially in consideration of this load, but more especially to direct students and faculty to consider solutions of Fleet ASW problems. It is recommended that the thesis requirement for students in the "Oceanography-ASW" curriculum be met by interdisciplinary study groups addressing themselves to specific problems of Fleet ASW. Each officer in the group would prepare a full report in the thesis format, of his facet of the study and which will be included in the group report. These specific problems could be provided by the sponsor or by agencies such as the ASW Systems Project (PM-4) in the Office of the Chief of Naval Material.

This arrangement is attractive for several reasons: 1) it will provide the faculty supporting this curriculum impetus to maintain currency of academic direction; 2) it would, hopefully, provide funding for organized Naval Postgraduate School research in ASW problems; 3) it would open up avenues for closer cooperation between the Naval Postgraduate School and the Navy laboratories and R&D activities involved in ASW programs; and 4) it would be intellectually stimulating for the student

group organizing and conducting cooperative research and reporting to consider solutions to problems of vital interest to their future.

2. The Oceanography--Acoustics Curriculum

The alternative oceanography curriculum will provide subspecialist (and perhaps a few specialists) oceanographers whose academic study is more concentrated in oceanography and underwater acoustics. Graduates of this curriculum will have the requisite education to direct the ASW-related portions of the Naval Oceanographic Programs. This curriculum should be considered for officers with a strong baccalaureate background in electronics and/or physics, or who have had previous ASW hardware-oriented training and experience.

The "Oceanography-Acoustics" curriculum would be essentially similar to the "Oceanography-ASW" curriculum with the following exceptions: 1) "Acoustics" will include Numerical Analysis as a basis for computer modeling techniques; 2) "Acoustics" will include no operations analysis; 3) "Acoustics" will not include the three graduate level electrical engineering courses; 4) "Acoustics" will include an additional course in Fundamental Acoustics; 5) "Acoustics" will include an additional course in Ocean Circulation. The curriculum in Oceanography-Acoustics would include 116 quarter-hours and would satisfy the requirements for the awarding of the Master of Science in Oceanography. This curriculum could fulfill the requirements for increased emphasis on underwater acoustics indicated in questionnaire responses by officers who have completed

oceanography graduate curricula and subsequently have been assigned to billets supporting ASW. [2]

3. Oceanography Training for ASW

As discussed in Appendix G, there are several Navy professional and technical schools involved in giving instruction in basic oceanography as related to the warfare specialties. It was shown that, in general, officer specialists of the URL in air (ASW) and submarine warfare received instruction with greater emphasis on the environment. For air ASW operators this instruction was provided at several sites in their progressive qualification and requalification. All submariners receive instruction in the Submarine Officer's Basic Course and are, in general, more intimately aware of environmental influences. For surface warfare officers, instruction in basic and applied oceanography is limited primarily to officers who are preparing for particular duties (e.g. ASW Officer, Commanding Officer or Executive Officer of an ASW ship, mine warfare officers, amphibious staff officers). If the organizations of various ships and staffs are examined it is apparent that there is a general need for many officers therein to possess an environmental awareness. For example, in ASW Destroyers the ASW Deck Officers and ASW Attack Team members very often are officers who have not been able to attend ASW schools. These officers should be provided training in ASW oceanography in order to improve the general level of Fleet ASW (or, similarly, mine warfare or amphibious warfare) performance.

Instruction in basic oceanography (and meteorology) could be accomplished in several ways: 1) strengthening or inserting environmental instruction into Officer Candidate School, Naval ROTC, and Naval Academy curricula for all officer candidates; 2) requiring all officers to attend instruction at Fleet Schools in oceanography; or 3) requiring completion of correspondence instruction in Fleet-oriented oceanography. The first method is entirely feasible and should be investigated. The second method is less desirable economically since travel monies and time away from primary duties are involved. The third method entailing the completion of correspondence instruction would appear to be the most desirable and least expensive over the long haul.

The two correspondence courses mentioned in Appendix G are presently available and their use should be considered by Type Commanders and Force Commanders. However, recent developments in the area of programmed instruction or self-teaching techniques are promising and consideration should be given toward producing such a course for basic and applied oceanography. An excellent Training Device is already in existence which would provide the structure and graphical aids for such a programmed instruction course. This device was prepared by the Navy Training Device Center, Orlando, Florida, in May 1969 to fulfill training material needs for Atlantic Fleet air ASW operators. Designated NAVTRACEN P-3534, Device 4B25, it has four sections (General Oceanography, The Acoustic Properties of Sea Water, Sonar Equation, and Applied Geophysics) which could apply equally well to air, surface or submarine needs in ASW

Oceanography or as a basic course in oceanography for other warfare subcategories. It is believed that this training device could be developed into a programmed instruction course with a minimum of effort and expense. It is recommended that this be accomplished and that, as a minimum, all officers attached to ASW surface ships should be required to complete this instruction. This course would be equally applicable to air and submarine officers and could be used to augment instruction presently received in schools or as refresher courses in repeat tours.

It is further believed that Training Devices, such as Device 4B25, represent an example of the type of common materials which could be provided to Fleet schools by the Navy Training Command. As asserted previously, the required content of a course in basic and applied oceanography is similar for air, surface or submarine officers. It would be a simple matter to update such materials to match the changing knowledge and emphasis in oceanography.

D. GRADUATE EDUCATION IN OCEANOGRAPHY FOR OTHER NAVAL APPLICATIONS

The following recommended curriculum options in oceanography have the objective of providing basic knowledge in oceanography and to have sufficient flexibility to meet the specific requirements of officers in the various parts of the Navy. Only the curriculum for specialists of SDO 1820 lacks the flexibility to allow some choice of program.

1. Recommended Curriculum for SDO 1820

As discussed previously, the developing trend toward unification of Navy environmental effort should ultimately lead to the establishment of a Naval Environmental Service. The new Physical Oceanography Curriculum 440 is endorsed for the environmental specialist of SDO 1820 who will serve in this corps. This curriculum has been included as Figure 10 in Appendix G. Consideration should also be given to providing this curriculum for experienced Meteorologists of SDO 1810. This will round out their backgrounds as environmentalists and will aid in breaking down provincialism among oceanographers, hydrographers and meteorologists who will form the Naval Environmental Service.

2. Recommended Oceanography Curricula for Subspecialists

Section III. D. outlined the academic areas within oceanography curricula which are necessary for more optimum performance of duties as a technical officer in Navy laboratories and R&D commands. The options indicated were ASW oceanography, marine acoustics, ocean engineering, general oceanography, marine geophysics, and marine biology. These areas of concentration encompass R&D in progress in the Naval Oceanographic Programs. In the past, officers attending civilian graduate programs in oceanography have been permitted to concentrate in these and other areas. However, at the Naval Postgraduate School the program has been fully specified by prerequisites, degree, and sponsor requirements. Officers have only been able to carry on advanced study in these areas through outside study and investigations for the Master's thesis. In order to provide for

the academic requirements of technical officers involved in R&D or operational test and evaluation, a very flexible format for study is recommended.

This flexibility would be provided by starting all inputs in oceanography, including the two ASW curricula previously discussed, in a common core of courses for the first several quarters. Prerequisites may vary somewhat; however, since all students must satisfy the departmental requirements in oceanography, it is possible to provide this common core of instruction in oceanography. Upon completion of this core or ocean package the ASW-oriented students will part company and complete the curriculum as sponsored by the Director, ASW Programs or the Oceanographer. Specialist oceanographers will continue concentrated environmental studies. Officers who are to become technical officers and managers in the Naval Oceanography Programs will be counseled on projected billet requirements and either: 1) allowed to choose an approved area of specialization for the remaining quarters; or 2) (if the needs of the Navy are well enough defined) directed to complete a required option. In the former case it is apparent that a real test of the flexibility of Postgraduate School programs would be achieved. However, it should be effective, if a student or a group of several students can arrange a program within established guidelines, which will be submitted for approval to the Curricular Officer for Environmental Science programs. This necessitates making available (well in advance) the courses which are to be taught by all

departments and insuring that sufficient students will enroll in the courses offered.

It is possible to identify several options which will fulfill the requirements of existing and projected billets for officers P-coded in oceanography. The following Table represents options to Physical Oceanography Curriculum 440, which could be offered to students. Courses in support of these options are either offered presently by departments at the Postgraduate School or could be readily developed by the faculty as presently constituted.

Table II. Possible Graduate Options in Oceanography

Oceanography-Physical (September 1971 revision)
Oceanography-ASW (Proposed herein)
Oceanography-Acoustics (Proposed herein)
Technology of Ocean Operations (Similar to
Suspended Curriculum, Figure 9, Appendix G)
Oceanography-Hydrography
Oceanography-Instrumentation
Oceanography-Management
Oceanography-Hydrodynamics
Oceanography-Geophysics
Oceanography-Marine Biology
Ocean Engineering

a. Arrangement of Curricula

As outlined in Appendix G, thirty-five quarter-hours of upper division oceanography courses, 15 quarter-hours of which are above the 4000 level, are required for the Master of Science in Oceanography. The following courses would represent the core of courses or ocean package which each officer must complete to satisfy the prerequisite, and the Department of Oceanography degree requirements before proceeding into

any of the several options recommended. These courses will be organized into a framework dictated by faculty teaching availability, and other courses which will satisfy other academic requirements of the sponsor will be fitted in at appropriate time-slots in the total eight-quarter program.

Table III. Prerequisites and Degree Requirements

Linear Algebra/Vector Analysis
Differential Equations
Partial Differential Equations
Descriptive Physical Oceanography
Geological Oceanography
Biological Oceanography
Chemical Oceanography
Scientific Cruise Experience
Dynamical Oceanography
Waves and Tides
Coastal Oceanography
One additional 4000 Level Oceanography Course

(1) Discussion of Options Available

If officers meet the entrance requirements all options discussed in Section IV. D. 2 can be completed in two years or eight academic quarters, with the exception of a full program in Ocean Engineering. To achieve the breadth of engineering education necessary for a Master of Science in Ocean Engineering a program of at least ten quarters or two and one-half years would be most appropriate. There are very definitely requirements for officers educated in this emerging field, not only in the two officer categories addressed in this study (URL-8710P and SDO 1820), but also in Engineering Duty (SDO 1400) and the Civil Engineer Corps.

The sponsors of Ocean Engineering graduate curricula for these two officer categories should consider the use of curricula tailored to their needs at the Naval Postgraduate School.

E. RECOMMENDED BILLETS FOR SPECIALISTS AND SUBSPECIALISTS

An analysis has been performed utilizing previous experience and available data to determine those commands which can justify the assignment of an officer possessing an advanced degree in oceanography. The policy guidelines of DOD and the Secretary of the Navy relative to funded graduate level study and validation of billets were applied. To summarize: in order that a billet may be validated as requiring an incumbent officer with graduate level education one of the following criteria must apply. Graduate level education is required: 1) for optimum performance of duty; 2) in order to supervise subordinate civilian and/or military personnel who must possess graduate level education; and 3) in order to allow effective staff planning, coordination and command advisory functions.

URL and SDO oceanography graduates are presently assigned a single P-code (8710) regardless of the curriculum completed. Billets are then identified by their requirement for an incumbent with a particular combination of grade, designator, P-code and other qualification codes. Since three basic curricula and several options in oceanography are recommended herein, the billets summaries will be presented in a manner which reflects only the basic curricula. In order to effect this system it will be necessary to create at least two new P-codes and then reallocate some billets to

reflect the new grouping. In the following three subsections new billets are recommended for validation as indicated. The summary of existing billets for SDO 1820 and RL (8710P) in Appendix I have been coded to indicate the option required and the recommended reallocation.

1. ASW "Specialist" Billets (8711P)

Table IV is a listing of billets or assignment areas which will either be necessary steps in achievement of "Expert" ratings within the AQD concept or senior management assignments for the qualified ASW expert. These billets are for the proposed AQD codes and P-codes to be assigned to graduates of either the "Oceanography-ASW" or the "Oceanography-Acoustics" curricula. No attempt will be made to indicate the grade or rank of the officer assigned, except to state that no billet is proposed for any officer below the grade of Lieutenant. Several billets ashore are indicated as being equally appropriate for either an ASW "specialist" or an oceanography "technical officer" who has graduated from one of the "Ocean Technology" options.

Table IV. Recommended Distribution of URL ASW "Specialists" (8711P)

1. Afloat Commands

Officer Designator	Activity Title	Billet or Section Title
Any	COMSECONDFLT	ASW/USW
Any	COMSIXTHFLT	ASW/USW
Any	COMSEVENTHFLT	ASW/USW
Any	CINCLANTFLT	ASW/USW
Any	CINCPACFLT	ASW/USW
1120	COMSUBLANT	ASW/USW
1120	COMSUBPAC	ASW/USW
1110	COMCRUDESLANT	Assistant ASW Officer
1110	COMCRUDESPAC	ASW Officer
13XX	COMAVAIRLANT	Air ASW

Officer Designator	Activity Title	Billet or Section Title
13XX	COMNAVAIRPAC	Air ASW
Any	COMASWFORLANT	Operations Section
Any	COMASWFORPAC	Operations Section
Any	COMOCEANSYSPAC	Operations Section
1120	All Submarine Flotilla Staffs (6)	ASW/USW
1110	All Destroyer Flotilla Staffs (8 additional)	ASW Officer
13XX	COMFAIRWINGSLANT	Air ASW
13XX	COMFAIRWINGSPAC	Air ASW
13XX	COMFAIRMED	Air ASW
13XX	All Fleet Air Wing Staffs (7)	Air ASW
1110	COMDESDEVGRU	ASW Development
1120	COMSUBDEVGRU ONE	ASW/USW
1120	COMSUBDEVGRU TWO	ASW/USW
1110	All Carrier Division Staffs (8)	Surface Operations/ASW
Any	COMASWGRU THREE	ASWEPS
1110	All Destroyer Squadron Staffs (28)	Any Billet
1120	All Submarine Squadron Staffs (13)	Any Billet
13XX	All Patrol Squadrons (VP) (26)	CO or XO or OPS
13XX	All Helicopter ASW Squadrons (HS) (9)	Any Billet
13XX	All Air ASW Squadrons (VS) (14)	Any Billet
1110	All Destroyer Types (175 projected)	CO or XO or OPS or WEPS
1120	All Attack Submarines (145 projected)	CO or XO or OPS or WEPS
13XX	All Patrol Squadrons (VP) (26)	All TACCOs
Any	COMHUKFORLANT	ASW Operations

2. Ashore Commands

Any	ASW Programs (OP-095)	Director
Any	ASW Programs (OP-095)	Deputy Director
Any	ASW Programs (OP-095)	OP-095A
Any	ASW Programs (OP-095)	OP-095C
Any	ASW Plans & Programs (OP-950)	OP-950C
Any	ASW Plans & Programs (OP-950)	OP-950D

Officer Designator	Activity Title	Billet or Section Title
1110	Technical Appraisal & Requirements (OP-951)	OP-951C
13XX	Technical Appraisal & Requirements (OP-951)	OP-951D
1120	Technical Appraisal & Requirements (OP-951)	OP-951E
Any	Technical Appraisal & Requirements (OP-951)	OP-951F
1120	Submarine Warfare Division (OP-31)	OP-311
1120	Submarine Warfare Division (OP-31)	OP-312
Any	ASW & Ocean Surveillance (OP-32)	OP-322
1120	Strategic Offensive & Defensive Systems (OP-097)	Staff
Any	Resch, Dev, Test and Eval (OP-098)	Staff
1120	Deputy CNO (Submarines) (OP-02)	Staff
1110	Deputy CNO (Surface) (OP-03)	Staff
13XX	Deputy CNO (Air) (OP-05)	Staff
Any	Chief of Naval Training (OP-099)	ASW Training
Any	Chief of Naval Material (PM-4)	Project Officer
1110	NAVSHIPSYSCOMHQ (PMS-380)	ASW Project ASST
1120	NAVSHIPSYSCOMHQ (PMS-385)	BQS-13 Proj. ASST
1110	NAVSHIPSYSCOMHQ (PMS-387)	SQS-26 Proj. ASST
Any	NAVSHIPSYSCOMHQ (PMS-394)	Acoustic Warfare
Any	NAVSEC	ASW Systems
Any	Bureau of Naval Personnel	ASW Coordinator
13XX	FAETUPAC DET, Moffett Field	ASW Instructor
13XX	FAETULANT, Norfolk	ASW Instructor
Any	Fleet ASW Tactical School NORVA	Commanding Officer

Officer Designator	Activity Title	Billet or Section Title
Any	Fleet ASW School San Diego	Commanding Officer
1110	Fleet Sonar School Newport	Commanding Officer
1110	Fleet Sonar School Key West	Director, Enlisted Training
1110	Naval Destroyer School	ASW OPS Instructor
1120	Naval Submarine School	ASW/USW Instructor
Any	All U.S. Naval Facilities (20)	Officer-in-Charge
Any	Officer Candidate School	Instructor
	Total Billets Recommended:	Afloat --- 484 Ashore---- 61

2. SDO 1820 "Environmentalist " Billets (8710P)

The following additional billets are recommended for environmentalists of SDO 1820 (8710P). The addition of billets in the Naval Operating Forces is meant to improve the overall Fleet environmental support and to provide the "environmentalist" familiarity with the current problems of the Operating Forces. In the listing of existing billets in Appendix I, several billets are indicated which appear to require an officer with graduate level education in oceanography and are therefore recommended for P-coding.

Table V. Recommended Additional Billets for SDO 1820 (8710P)

1. Afloat Commands

Activity Title	Billet Title
COMSUBLANT	Environmentalist
COMSUBPAC	Environmentalist
COMFAIRWINGSLANT	Environmentalist
COMFAIRWINGSPAC	Environmentalist
All ASW Groups (4)	Environmentalist
Deploying Cruiser-Destroyer Flotillas (2)	Environmentalist

Activity Title	Billet Title
Deploying Amphibious Groups (2)	Environmentalist
COMOCEANSYSLANT	Environmentalist
COMOCEANSYSPAC	Environmentalist
COMASWFORPAC	Environmentalist
COMFIRSTFLT	Environmentalist
COMSECONDFLT	Environmentalist
COMSIXTHFLT	Environmentalist
COMSEVENTHFLT	Environmentalist
COMHUKFORLANT	Environmentalist

2. Ashore Commands

Activity Title	Billet or Section Title
NOAA	Navy Liaison
EPA	Navy Liaison
Naval Material Command	Environmental Analyst
NAVSHIPSYSCOMHQ	Environmental Analyst
Office of Naval Research	Environmental Research
CNO (OP-33M)	Oceanographic Forecasting
CNO (OP-45)	Environmental Analyst
Bureau of Naval Personnel	Geophysics Detail Officer
COMFIFTEEN*	Oceanographer
CNO (OP-954C)*	Asst for Deploy. Systems
CINCPACFLT*	Maps, Charts and Geodesy
Fleet ASW School, San Diego*	Surface ASW Instructor
NUSC, New London Lab*	Ocean Survey
U.S. Naval Academy*	Oceanography Instructor
Fleet Sonar School, Key West*	Sound Physics Instructor
NAVSTIC*	Oceanographic Analyst
COMOCEANSYSPAC*	Plans

Total Billets Recommended: Afloat---21
Ashore-- 11

* Indicates existing billets recommended to be P-coded.

3. Oceanography Subspecialist "Technical Officers" Billets (8712P)

It is recommended that the following additional billets be P-coded for officer graduates of the recently suspended trial curriculum, Technology

of Ocean Operations, and for future graduates of the recommended curriculum options for "technical officers."

Table VI. Recommended Billets for "Technical Officers" (8712P)

1. Afloat Commands

Officer Designator	Activity Title	Billet or Section Title
111X	Mine Warfare Force	Operations
111X	All Mine Flotillas (3)	Operations
112X	COMSUBDEVGRU ONE	Vehicle Development
112X	COMSUBDEVGRU TWO	Operations
112X	USS Dolphin (AGSS-555)	CO/XO
112X	USS NR-1	Officer-in-Charge
112X	Deep Submergence Rescue Vehicle (2)	Officer-in-Charge
112X	Deep Search Vehicles (2)	Officer-in-Charge

2. Ashore Commands

Officer Designator	Activity Title	Billet or Section Title
11XX	Coordinator, DSSP	(OP-03U) Staff
11XX	NAVSHIPSYSCOMHQ (PMS-395)	DSSP Project Officer
11XX	NAVSHIPSYSCOMHQ	Supervisor of Salvage
11XX	Office of Naval Research	Project Officer
11XX	Naval Research Laboratory	Project Officer
11XX	Naval Ships R&D Laboratory, Carderock	Project Officer
11XX	Naval Ships R&D Laboratory, Panama City	Project Officer
11XX	Naval Ships R&D Laboratory, Annapolis	Project Officer
11XX	Naval Ships Engineering Center	Project Officer
11XX	Naval Undersea R&D Center, San Diego	Project Officer
11XX	Naval Undersea R&D Center, Hawaii	Project Officer
11XX	Naval Civil Engineering Laboratory	Project Officer
11XX	Naval Air Development Center, Warminster	Project Officer

Officer Designator	Activity Title	Billet or Section Title
11XX	Naval Mine Defense Laboratory, Panama City	Project Officer

Total Billets Recommended: Afloat -- 13
Ashore -- 14

IV. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

This final section will summarize the conclusions and recommendations of this study. All have been discussed in other sections but are included separately here for clarity and emphasis.

A. CONCLUSIONS

1. An understanding of the ocean, its character and its dynamic processes, offers the greatest opportunity for improvement of the capabilities of Navy ASW Operating Forces. This understanding must be held by those who supervise design of ASW sensors and weapons, by those who support the operation of the ASW forces deployed at sea, and by those who must apply all contributing knowledge to the employment of ASW hardware on, under and above the ocean.

2. Fleet training in oceanography will enhance an officer's understanding of the ocean, but the too infrequent exercises under staged conditions do not develop sufficient expertise in solving the "real ocean" ASW problem.

3. Those who support ASW operations at sea with environmental data are, for the most part, properly educated and capable in their assignments,

but are hampered by an organization which is compartmented in its support role between those who support aviation efforts and those who support surface and submarine forces. Furthermore, the environmental specialists are not afforded very necessary intimate contact with the problems of the Operating Forces; nor are officers of the operating forces familiar with the problems of the environmentalist.

4. Officers who provide management supervision and administration of ASW design and development projects require increased appreciation for the effects of the real ocean on ASW sensors and weapons.

5. The officers who have received funded graduate level education in oceanography are not being adequately utilized in ASW billets at sea or ashore. Sufficient billets do not exist and existing billets are not filled by these officers. Problems exist in the rank structure of these officers, but a principal reason for inadequate usage is that a significant number of commanders believe that an URL officer who completes advanced study in oceanography will devote his primary attention to further scientific investigation of the oceans. In actuality, an officer with this special background will function normally in the duties of his warfare specialty, but his increased knowledge of the ocean and its effects on underwater sound make him particularly able to function as an operator or an adviser in the ASW environment.

6. The general level of knowledge of the ocean environment is inadequate among Naval officers serving in ASW surface ships and in other

units tasked with missions in other warfare subcategories such as amphibious warfare and mine warfare.

7. Recent changes in the oceanography graduate curricula available to Naval officers are not attractive to Unrestricted Line Officers--neither does the single, new oceanography curriculum at the Naval Postgraduate School fulfill all of the educational requirements in oceanography and related disciplines for technical billets in areas such as ocean engineering, sensor development, instrument development, weapons development and hydrographic engineering. The requirement exists for advanced, related technical and managerial education outside of the purely environmental study contained in the revised Physical Oceanography (440) Curriculum at the Naval Postgraduate School.

8. Graduate level technical education in any field is often considered out of context with the overall career of Naval officers. This education is considered by many URL officers to be essential to insure future promotion rather than to be essential to fulfill the educational requirements for optimum performance of duties in future billets.

9. Establishment of an interdisciplinary graduate study program directed toward antisubmarine warfare operations and hardware is absolutely essential to compensate for inadequacies in peacetime operational emphasis on ASW. Required officer skills and unit employment in other warfare subcategories for the Vietnam conflict have contributed to this reduction in emphasis. During this same period, advanced ASW hardware has been installed in Fleet units which requires greater knowledge and skill

for optimum employment. A primary threat remains in the extensive Soviet submarine forces.

B. RECOMMENDATIONS

1. Officially adopt warfare subcategory specialization in ASW for URL officers. This specialization will afford qualified officers in the warfare specialties (air, surface and submarine) the opportunity of serving in repeated tours in ASW billets, both at sea and ashore, and completing advanced education which is directed toward optimum performance in all future billets. Repeated tours, training and education will provide experts at the end of the first 12-14 years of commissioned service who will be more capable ASW commanders at sea and more capable ASW program managers and administrators ashore.

2. Take early steps to stabilize officer and enlisted assignments in ASW units in the Fleet.

3. Provide more frequent and more realistic ASW training at sea than is presently available. Coordinated exercises involving air, surface and submarine forces, and surveillance and environmental activities are absolutely essential.

4. Identify billets which will provide the qualifications through an Additional Qualifications Designation in ASW. Identify senior officer billets ashore and afloat that require officers who have achieved the qualifications of "ASW Operational Expert" and "ASW Technical Expert." In the interim,

officers with ASW experience and advanced study in oceanography should be considered for these billets.

5. Establish an interdisciplinary curriculum of study in the contributing disciplines of ASW at the Naval Postgraduate School. The Department of Oceanography is recommended as the "lead agency" in the administration of this curriculum and the director should be responsible directly to the Provost. Award the Master of Science in Oceanography (ASW) to qualified graduates of this curriculum. Utilize these graduates in billets discussed in 4 (above).

6. Q-code ASW billets for initial assignment of graduates of technical baccalaureate curricula (such as B.S. in Oceanography from the Naval Academy). Successful completion of these assignments will establish eligibility for specialization in ASW and assignment of quotas to ASW graduate curricula.

7. Assign interested and qualified warrant officers and limited duty officers, who have technical and operational experience in ASW, to baccalaureate study in Oceanography at the Naval Postgraduate School.

8. Officers who will become specialists of SDO 1820 (8710P) should complete the present Physical Oceanography Curriculum (440) at the Naval Postgraduate School.

9. Billets established in the ASW Operating Forces and other units for SDO 1820 officers in order to enhance consideration of environmental effects in the Operating Forces and to provide the specialist needed appreciation of operational problems.

10. Establish a flexible degree program in Oceanography to provide a broad range of topics in related fields. Establish a core of courses to satisfy prerequisite and degree requirements. Additionally, prepare several options to go with the core, including: acoustics, geophysics, hydrography, ocean engineering and others. All programs will lead to the awarding of the Master of Science in Oceanography.

11. Identify billets for graduates of the above technical options in Navy R, D, T&E activities and within the Naval Material Command and the Systems Commands.

12. Provide programmed, self-teaching materials in General and ASW Oceanography to improve the level of understanding of the environment in the Navy Operating Forces.

13. Coordinate all Navy environmental matters by the establishment of a Naval Environmental Service. This Service will combine the Naval Oceanographic Office and the Naval Weather Service Command under a unified administrative structure. Officers in the Geophysics Special Duty category (oceanographers, meteorologists and hydrographers) will then be able to efficiently perform the principal functions of this service on a worldwide basis.

APPENDIX A

SELECTED GLOSSARY OF TERMS

Line Officer: This term can be applied to all officers of the regular Navy and Naval Reserve except officers of the staff corps.

Unrestricted Line Officer: A category of officers including officers of the line of the regular Navy and the Naval Reserve who are not restricted in the performance of their duty and who are eligible for command at sea (e.g.; surface warfare, submarine warfare and air warfare officers). The specialty of an URL officer is naval warfare. [27]

Restricted Line Officer: Those officers of the line of the regular Navy and the Naval Reserve who are restricted in the performance of duty by having been designated for engineering duty, aeronautical engineering duty, or special duty, and who are not eligible for command at sea. [27]

Limited Duty Officer (LDO): An officer of the regular Navy appointed for the performance of duty in the technical fields indicated by his previous warrant category or enlisted rating.

Subspecialty: A subspecialty is a significant qualification in a particular field of naval endeavor, other than naval warfare, obtained through graduate or baccalaureate level education, practical experience, or a combination thereof. A subspecialty is a career development field secondary to the

specialty of naval warfare. The objective of the subspecialty concept is to meet the present and future needs of the Navy for officers well qualified in technical and managerial areas.

Subspecialists are identified by a code composed of four digits and a one-letter suffix; e.g., 8321P. [20] The one-letter suffixes such as D, P, and S, utilized in conjunction with the four-digit identifiers, indicate levels of qualification generally defined as:

(a) D-code. D-codes will be assigned to those billets to which it is essential to assign officers with a Doctoral level education for optimum performance of duty.

(b) P-code. P-codes will be assigned to those billets to which it is essential to assign offciers with a Master's level education for optimum performance of duty.

(c) B-code. B-codes will be assigned to those billets where all criteria for D- or P- coding are met but the supply of D- or P- coded officers is presently inadequate to meet the requirements. B-coding identifies the requirement for officers educated at the Master's level or beyond, but places the billets in a priority sequence such that all D- or P- coded billets, as appropriate, are to be filled before D- or P- coded officers are assigned to B-coded billets.

(d) S-code. S-codes will be assigned to those billets to which it is essential to assign officers with specialized experience or training, or with a level of education less than the Master's level for optimum performance of duty.

(e) Q-code. Q-codes will be assigned to those billets which provide the required training or experience to qualify an officer for an S-code. [24]

Subspecialty codes are assigned to officers of both the unrestricted and the restricted line.

Geophysics Special Duty Officer (1820 Designator): This category is assigned to officers of the Restricted Line whose specialty is geophysics--oceanography or hydrography. These officers should be graduates of an accredited college or university with a degree in the field of oceanography, geophysics, photogrammetry, geodesy, or engineering (with emphasis on survey engineering for hydrography or marine engineering for oceanography) or who have completed graduate study under the Navy's Postgraduate Program in related fields. Operations experience at sea or in an oceanography or hydrography billet for a minimum of two years is highly desirable. [20]

Officer Code Advisor: Commanders of Navy commands, bureau chiefs, and heads of other offices of the Navy who advise the Chief of Naval Operations and the Chief of Naval Personnel in manpower and personnel matters involving the various officer categories in the Navy (defined above). Subspecialty advisers further advise concerning subspecialty billet requirements, qualitative criteria for identifying billets in areas of responsibility, qualitative criteria for identification of subspecialists, and billet descriptions within subspecialty areas of responsibility. The adviser is

additionally designated as primary curricular adviser for educational programs associated with the appropriate subspecialty. [28]

APPENDIX B

ANALYSIS OF QUESTIONNAIRE RESPONSES

Two questionnaires were distributed in conducting this study: 1) a student survey distributed to all Naval officer students in the Oceanography curricula at the Naval Postgraduate School in October 1971 and 2) a survey discussed in Section I distributed to officers and civilians involved in the Naval Oceanographic Program which was also distributed in October 1971. The results of these two surveys will be summarized briefly herein.

1. Student Survey

This questionnaire was distributed in order to determine two general items of interest. First, what is the Service background of officer students in oceanography? Second, what motivated these officers to choose oceanography as their field of graduate level study?

Seventy-two questionnaires were distributed with a 63% response (46/72). These officers were distributed in warfare specialization categories as follows:

SURFACE	31/46 -	66%
SUBMARINE	7/46 -	15%
AVIATION	8/46 -	17%

Officers are afforded the opportunity of indicating three selections of postgraduate curricula in order of preference on their data card indicating preference of duty (NAVPERS 1301/1). Eighty-one percent of the respondents indicated Oceanography as their first choice.

The service experience of the students was analyzed by billets previously occupied within each warfare category. The following paragraphs are presented by warfare specialty area.

a) Surface Warfare Officers (66% of respondents)

In this analysis, previous duties were divided into three categories. First, those officers who have completed a tour of sea duty as Antisubmarine Warfare Officer or Weapons Officer on an ASW-capable ship. Second, those officers who have completed a tour of sea duty as Operations Officer of an ASW-capable ship. Lastly, those officers who have either not served in an ASW-capable ship or who have not served in billets of the first two categories. The data for Surface Warfare Officers is summarized as follows:

BILLETS	NUMBER/TOTAL	PERCENTAGE
ASW or Weapons	19/31	61.3%
Operations	5/31	16.1%
Others	7/31	22.6%

b) Submarine Warfare Officers (15% of total)

Previous duties for submarine officers were divided into only two categories: those officers having filled duties as Sonar and/or Weapons Officer in submarines and a second category which includes those who have not served in these billets. Only one of the seven respondents had not filled a Sonar or Weapons Officer billet prior to reporting to the Postgraduate School.

BILLETS	NUMBER/TOTAL	PERCENTAGE
Sonar or Weapons	6/7	85.7%
Others	1/7	14.3%

c) <u>Air Warfare Officers</u> (17% of total)

A somewhat different approach was necessary in analysis of air officers. These officers will be categorized by the type of aircraft squadron in which they have served. Patrol (VP) and Air ASW Squadrons (HS and VS) carry out a primary mission of antisubmarine warfare and therefore would have experience in relation to the oceanic environment. Fighter (VF) and Attack (VA) Squadrons on the other hand are little concerned directly with occurrences beneath the surface of the ocean.

SQUADRON	NUMBER/TOTAL	PERCENTAGE
VP/VS/HS	3/8	37.5%
VA/VF	5/8	62.5%

These are rather interesting results. All five officers who have served in VA or VF squadrons are pilots who will have no possible opportunity to serve in a P-coded billet in oceanography for several years without significant risk to their future promotion opportunities. The three officers who have served in VP/VS/HS squadrons are professional air ASW operators. Assignment to a P-coded oceanography billet is not detrimental to their future career development.

d) <u>Motivation for Choosing Oceanography Curriculum</u>

The principal factors motivating the respondents to choose the oceanography curriculum for their graduate study are listed in Table VII with the numbers of officers who responded for each.

Table VII. Motivation for Choosing Oceanography Curriculum

1)	Curriculum represents study of environment in which Navy operates	14
2)	Developing Navy field promising attractive billets	9
3)	Significant contribution to personal capability in ASW	8
4)	Previous undergraduate study or experience in oceanography	7
5)	Consideration in future civilian employment	3
6)	More attractive technical curriculum than others	2
7)	Curriculum recommended by senior officer	2
8)	No reason given	1
		46

2. Survey of Navy Participants in Naval Oceanography Program and ASW

A questionnaire was mailed to officers and civilian managers in five basic Navy command classifications: Type or Force Commanders; Navy Laboratories; Navy training schools and educational sites; Major Fleet Commanders, and a general category for officers who did not serve in organizations above. In all, 131 letters of these five types were forwarded in mid-October 1971. Fifty-six responses were received for a response rate of 42.7%. Unfortunately, no responses were received from staff officers of the Major Fleet Commands: Pacific Fleet, Atlantic Fleet; First, Second, Sixth and Seventh Fleets.

The questionnaire was an opinion survey which will not be analyzed to cite statistics. Its purpose was to determine the opinion of persons within the Naval Oceanographic Program and of Fleet users of environmental data concerning the education and training of officers in oceanography to meet the needs of their commands. Since many of the commands polled had no billets validated for URL P-coded or SDO 1820 officers, the questions solicited the major reasons for not validating billets for such officers. Other questions solicited opinion concerning general and specific summaries of the type and extent of oceanographic study required by officers within the organization of the polled individual. Many interesting and pertinent responses were received which this writer greatly appreciates. Several of these responses will be paraphrased and included below:

a) A Navy laboratory technical officer suggested that all post-graduate curricula for Naval officers should include introductory courses in oceanography and underwater acoustics.

b) A Destroyer type commander felt that each officer within his command required a fundamental knowledge of the basic principles of oceanography. General cutbacks in personnel were frustrating his efforts to obtain validated billets for an URL Officer P-coded 8710 within his staff.

c) A senior naval officer commanding integrated ASW forces indicated that he needed more officers with a good background in oceanography, underwater acoustics, signal processing and operations analysis to bridge

the gap between technical commands and the operating Navy. He felt a strong need to identify ASW specialists and to establish attractive career patterns for them.

d) A senior officer in an ASW training school identified the need for a recognized career pattern for Oceanography/ASW specialists and suggested further indoctrination in environmental influence was required for Fleet ASW Commanders.

e) An officer-manager in the Navy Department suggested that commanders high in the Navy organization need to specify which billets are to be P-coded since local commanders have been hesitant or unable to recognize their special needs in oceanography. He further stated that the role to be fulfilled by SDO 1820 officers remains unclear.

f) A civilian department head in a Navy laboratory conducting R&D in seafloor construction and ocean engineering felt no need for a technical officer educated in oceanography or ocean engineering.

g) Two officers on a staff of integrated ASW forces suggested that the oceanography degree programs must place considerable emphasis on underwater acoustics.

h) A senior staff officer of a Destroyer Force command could not justify an 8710 P-coded billet due to the minimal time his special training would be needed. He nevertheless desired such an officer if his assignment was not at the expense of existing billets.

i) A civilian oceanographer-consultant stated that all officers in the submarine forces need some training in oceanography and that each

submarine has a need for an officer with an MS in Oceanography (8710P). The curriculum for this officer should include: general oceanography, acoustics, oceanographic tactics, and ASW Operations Research.

j) An ASW school instructor stated that officers most suited to become ASW specialists are those possessing environmental training. Oceanography should be strongly oriented toward ASW.

k) A second ASW school instructor advocated the use of programmed instruction as a means of environmental instruction to alleviate severe time constraints in ASW schools. He furthermore stated that more co-ordination was needed in fleet applied oceanography training.

l) The commander of an R&D activity felt the need for an officer with environmental expertise to be available on his staff, but the actual title of the billet he would occupy would be an unimportant consideration. However, all technical billets were P-coded in other fields (than 8710P). His needs were for a physical oceanographer with emphasis on acoustics and sonar systems engineering.

m) A senior officer in Ocean Science Programs stated that his needs were for scientific program administrators with advanced education in oceanography, combining physical oceanography and acoustics.

n) A senior officer with significant ASW experience stated that all specialties and subspecialties needed more orientation toward ASW support. He suggested a well-rounded course in applied oceanography including underwater physics is a must to meet needs in ASW.

o) An officer assigned to a Fleet Weather Central stated that specialist oceanographers (SDO 1820) needed more emphasis on underwater acoustics and ASW applications.

p) An officer in an Ocean Engineering and Development project stated that ocean engineering officers in R&D project management in the Material Command and the Systems Commands are very definitely required. These needs are for officers in Engine ring Duty Specialties, Civil Engineer Corps and URL P-coded officers.

q) An ASW staff officer suggested more emphasis be placed on underwater acoustics and oceanographic prediction in oceanography education programs.

r) From an aviation officer: Patrol Air Squadrons (VP) each need one officer P-coded in oceanography to train Tactical Coordinators (TACCO's).

APPENDIX C

SUMMARY OF PREVIOUS RELATED STUDIES

A. WEAKLEY-DANIEL BOARD

This board, convened 23 January 1956 by the Chief of the Bureau of Naval Personnel, was to "review all aspects of Postgraduate Educational Programs and to make recommendations pertinent to current and future educational requirements and officer career planning." [29] Under the direction of RADM C. E. Weakley and RADM H. C. Daniel the Board reviewed the educational requirements for Navy billets and submitted conclusions and recommendations as follows:

1. Postgraduate Education should generally further an officer's professional and technical knowledge in a field in which he has had operating experience during his First Operational Phase (5 years after commissioning).

2. Postgraduate education should primarily fulfill technical and managerial requirements of a given billet, but should additionally provide the officer an "equality of opportunity, detailability, and the attainment of a degree both as an incentive and for purposes of prestige." [29]

3. Officers provided graduate education opportunities should complete a minimum of two "payback" tours (ashore or afloat) in their specialty area; the first tour should fall in the 12th-14th years of commissioned

service. The term "specialty" used here is equivalent to the term "subspecialty" in later sections.

4. The Board identified 4500 billets requiring advanced education and concluded that a total of 8000 officers, properly educated, were required to keep those billets filled. At that time there were 5400 Naval officers with advanced education, many of whom could not fill identified billets because of inappropriate postgraduate qualification or grade requirements of the billets.

5. The Board found no billets requiring an incumbent Doctor of Philosophy and concluded that the Ph. D. tended to limit officer qualification for general service.

6. No tangible evidence was found to indicate that URL Officer careers suffered by remaining in postgraduate courses for three years. However, the board recommended that technical education be limited to officers in the grades of Lieutenant Commander and below, and that average course lengths of two years be standardized.

7. Several new postgraduate programs were recommended by the board. However, Oceanography was not among those recognized as a curricular requirement at the Naval Postgraduate School and no billets for oceanography graduates were identified. [29]

B. DILLON BOARD

This board, under the chairmanship of the Administrative Assistant to the Secretary of the Navy, John H. Dillon, was convened 29 March 1962

to review the management of the Department of the Navy. [24] The objective was to achieve maximum responsiveness of the Department of the Navy to Navy Operating Forces and to the Secretary of Defense. Although this board's broad coverage was not directed specifically toward oceanographic manpower in Navy Department programs, it does contain conclusions which are generally pertinent to this area. Briefly summarized, they are as follows:

1. Personnel who seemed best qualified for technical careers were not motivated toward postgraduate technical education. A belief existed that duty in key technical positions in bureaus and shore activities adversely affected promotional opportunities. URL officers sought, when possible, duties with the Office of the Secretary of Defense, the Joint Chiefs of Staff, the Chief of Naval Operations, and the Office of the Secretary of the Navy, in preference to duties in the technical bureaus and other shore activities.

2. As a result of the above attitudes the Board recommended a strong policy statement by the Secretary of the Navy supporting the desirability of technical education and subspecialization for officers and apprising selection boards of service needs in technical, managerial, and operating specialties. (SECNAV Instruction 1520.4 of 7 March 1963 resulted).

3. The Board concluded that Research and Development programs were geared to hardware and that systems were being designed without meaningful specification as to the level of individual who would actually be available to use, operate and maintain the systems.

4. It was recommended that the Navy consider educating Naval officers to meet future trends, rather than to meet the requirements of specific technical and managerial billets. [30]

C. COMBS BOARD

On 3 August 1964, the Chief of Naval Operations convened a board, chaired by RADM W. V. Combs, to study the billet requirements and grade distribution in the subspecialty and specialty areas in the Navy. [30] This board obviously was tasked with clarifying and correcting manpower management deficiencies pointed out by the Dillon Board. The report was preceded in publication by two Navy directives which established the Navy subspecialty concept (OPNAVINST 1040.2 of 9 December 1963) and which laid down the subspecialty program, including sponsorship and advisorship of the various categories (OPNAVINST 1211.6 of 22 September 1964).

The board considered required officer billet projections through fiscal year 1975. Billets were identified which for optimum performance required: a specialist (RL Officer); a specialist with graduate education (P-coded); an URL officer having a P-code; an URL officer having an S-code; or a RL or an URL officer having a doctorate degree (D-code). [30] Pertinent conclusions and recommendations of the Combs Board follow:

1. It was expected that officer career patterns would undergo some modification to reflect greater channelization of assignments, both at sea and ashore, into billets relating to subspecialties.

2. Flag officer billets should not be P-coded.

3. Only under the most unusual circumstances should billets for the grades of Ensign and Lieutenant (junior grade) be P-coded.

4. The board identified 38 officers having graduate level education in Oceanography to fill 62 billets. Similarly there were 7 hydrographers with advanced educations to fill 11 existing billets.

5. The board identified no billets in the Environmental Sciences for which S-coding was appropriate since all billets were felt to require graduate level education. The board further concluded that "officers cannot become qualified oceanographers by experience alone." (30)

6. A total of 193 billets were identified for which the doctorate degree was appropriate. Four such billets were identified for oceanographers.

7. Several billets in the Oceanography/Hydrography area were aligned with requirements for officers having a specialty area. Consequently, the Combs Board recommended that a separate study be conducted toward establishment of a specialist category in the Environmental Sciences. Such a category would include the disciplines of Oceanography, Hydrography and Meteorology. (Meteorology was already established as RL Specialty Code 1530).

8. Minimum requirements for assignment of a P-code in Environmental Sciences were specified as follows:

a. Be a school graduate from a Navy-sponsored postgraduate

program in meteorology, environmental science (meteorology), oceanography, environmental science (oceanography) or hydrographic engineering.

b. Have a Master's Degree or its equivalent in study in any of the areas in a. above.

c. Minimum requirements for assignment of an S-code in Environmental Sciences were a baccalaureate degree in meteorology, oceanography, physics, mathematics, marine geology or related fields and one tour in a designated environmental science subspecialty or qualifying billet related to the degree. [30]

D. ALFORD BOARD

Recognizing myriad problems in retaining personnel in the Navy and Marine Corps, Secretary of the Navy Paul Nitze chartered a task force on 22 December 1964 to identify and examine major factors bearing on retention of high quality officer and enlisted personnel. [31] Under the chairmanship of RADM J. M. Alford, the task force was also to develop a plan for attacking retention problems through examination of education and training opportunities, promotion and advancement, and personnel distribution policies, among others.

Among the Board's findings and recommendations applicable here were:

1. Educational opportunity was a vitally important career incentive.

2. Between 40 and 50 percent of existing URL billets could have been filled by officers from <u>any</u> of the three warfare categories (surface,

submarine, aviation). It was therefore recommended to generalize warfare category requirements for billets except where optimum performance was clearly possible only from a particular community of officers.

3. The management experience gained in a subspecialty assignment can make a substantial contribution to an officer's ability to fill his command responsibilities at sea. Conversely, sea experience can reinforce his value in his subspecialty.

4. Long postgraduate programs and repeat tours militate against progressive qualification of officers and jeopardize promotion potential, particularly in the aviation community up to the rank of Commander.

5. Officers with graduate education experience a favorable promotion opportunity and high retention.

6. An in-depth study into URL problems associated with the conflicting requirements of the generalist versus the specialist was recommended. [31]

E. WATERS BOARD

Under the direction of the Oceanographer of the Navy RADM O. D. Waters, Jr., a board of officers was convened 29 May 1968. [32] Their purpose was to make recommendations to the Chief of Naval Operations concerning a proposal to establish a Special Duty Officer category in Hydrography and Oceanography.

The Board recommended the following:

1. Such an SDO category should be established to include the

disciplines of oceanography, meteorology, geophysics and underwater acoustics (environmental). Within the SDO category to be designated Geophysics (18XX) should be two groups: a) 181X Meteorology and b) 182X Oceanography/Hydrography.

2. The new 181X category should be formed by those officers assigned to the existing SDO 153X community of meteorologists.

3. The Commander, Naval Weather Service Command (CNWSC) should be assigned additional duties as Assistant Oceanographer of the Navy for Environmental Prediction Services. The Commander, NWSC, should act as the curriculum sponsor and subspecialty adviser for meteorology categories.

4. The Oceanographer of the Navy should act as curriculum sponsor and subspecialty adviser for oceanography categories.

5. Special Duty Officers (1820) should be substituted for URL officers in existing Oceanographic Research Watch Officer billets in Naval Facilities and Commander Ocean Systems (Atlantic and Pacific) organizations. This would provide very junior officers motivational incentive to a viable career pattern not previously available as URL officers. The board further posed the possibility of an oceanography curriculum option in underwater sound for such officers. [32]

F. FUTURE PROFESSIONAL MANPOWER REQUIREMENTS STUDY

On 25 May 1969, the Chief of Naval Operations convened a study panel whose objective was to forecast the Navy's professional manpower

needs, both officer and civilian, for 10 years into the future. [33] This study was sponsored by the Deputy Chief of Naval Operations (Manpower and Naval Reserve) and was directed by the Assistant Deputy CNO (Manpower), RADM B. H. Shupper. To assist in the study Battelle Memorial Institute provided a 10-year projection of the national trends in the professional manpower utilization fields (occupations or specialties).

In conducting the study panels of officer and civilian experts in a given professional field within the Navy Department were assembled to consider the trends provided by Battelle Institute in conjunction with DOD and Navy long range planning documents. Panel members then individually predicted a growth factor for officers and civilians within a given subspecialty (P-code for officers) to apply for the 10-year period. Widely divergent growth factors were averaged and then smoothed by the collective experience of the panel. [33]

At the time of the study there were 135 billets for officers P-coded in Air-Ocean Environment, Oceanography, and Hydrographic Engineering. The panel on Ocean Science and Engineering predicted an overall change factor of 3.1--a growth of 310% in the 10-year period.

Broken down by the type of organization with which these billets are associated, the change factors are as follows:

ORGANIZATION	OFFICER CHANGE FACTOR
Operating Forces	4.0
Support Activities	3.3
Headquarters Activities	1.9
Research and Development	3.0
Overall	3.1

Several fields were considered, for which the growth factors predicted were so variable that their total range was indicated. For example: ocean engineering change factors ranged from 4.0 to 9.0; environmental acoustics from 3.0 to 6.0. These factors were considered invalid since the data base of existing P-coded billets was extremely small or nonexistent. [33]

Significant conclusions and recommendations of this study follow:

1. At the time of the study there existed 4775 P-coded billets for Naval officers (URL, RL and Staff Corps). By 1979 the study projected a need for 7600 total P-coded billets. (Note: The Weakley-Daniel Board had identified 4500 billets requiring advanced education in 1956. In 13 years the growth in these billets was only 225.)

2. The P-code criteria have not been applied as consistently in the Restricted Line and Staff Corps as in the Unrestricted Line.

3. An URL officer can expect to fill P-coded billets for only 4-6 years of his career and for no more than 3 consecutive years.

4. Ocean Engineering and Oceanographic Systems Engineering are considered emerging fields in the Navy.

5. "Present requirements for oceanographers and ocean engineers may be largely unfulfilled." [33]

6. Very large increases in numbers of oceanographers and ocean engineers were necessary to provide the Navy with up-to-date scientific and technical know-how to fulfill numerous and complicated tasks in research and development.

7. Each Fleet and Force command needed at least one officer or civilian oceanographer. Major fleet ASW commands (ASW Groups, Destroyer Squadrons, Patrol Squadrons, a large percentage of the nuclear attack submarines, major fleet escorts, flagship types, SQS-26-equipped ships, Escort Squadrons, Destroyer Divisions and ASW patrol ships) and search and recovery vehicles each required an officer-oceanographer.

8. It was not realistic to plan for the use of URL officers in professional manpower billets prior to the grade of Lieutenant Commander. However, Restricted Line officers often received graduate education early enough for use in Lieutenant billets.

G. STUDY INTO OCEANOLOGICAL SUPPORT FOR ASW

This study is the most recent and most pertinent report to be summarized. Acknowledging failure of ASW programs to use 1) "those officers receiving oceanography degrees" and 2) "an ASW-oriented oceanological support capability," the Chief of Naval Operations initiated this study on 26 September 1970. [2] The study was chaired by the Oceanographer of the Navy with sponsorship and guidance of the Director, Antisubmarine Warfare Programs (CNO, OP-095). A broad study was conducted into the entire spectrum of oceanological support for ASW, and recommendations for implementation were made as follows:

1. The Navy Postgraduate School's Oceanography curriculum offered that knowledge of the environmental disciplines which was vitally essential in the makeup of the ASW officer. However, oceanography postgraduates

were not being effectively employed within the Navy to support the overall ASW effort. The study recommended a review of existing billet allocations for SDO 1820 specialists and URL P-coded (Oceanography, 8710) subspecialists with a view towards placing more of these officers on ASW staffs, ships, and aircraft.

2. The capabilities of the Fleet ASW schools should be augmented to insure instruction in the relevant sciences and technology. Fleet ASW school curricula should include relevant theory, i.e.; oceanography, engineering, acoustics, electronics, signal processing, etc., as well as practical advanced training in the latest tactics, equipments, and applications. It was not considered feasible to devise a curriculum at the Naval Postgraduate School designed solely for ASW/USW application. Furthermore, officers educated in the environmental sciences should attend ASW school prior to assuming an oceanography P-coded ASW assignement.

3. Due to imbalances between URL P-coded rank distrbution and authorized billet structure, it was recommended that the billet structure be adjusted to reflect a significant increase in P-coded billets for Lieutenant Commanders.

4. Newly-commissioned officers possessing baccalaureate degrees in the environmental sciences should fill ASW billets in their initial assignments. This program must allow those officers, so desiring, to be S-coded on attainment of a sufficient level of Fleet ASW expertise. [2]

Further analysis and the statistical results of this study are included in Appendix G.

APPENDIX D

NAVY EDUCATION AND TRAINING POLICIES

A. EDUCATION

In order to adequately evaluate existing manpower programs it is necessary to determine the policy constraints under which the system functions. The more pertinent education and training policies will be briefly summarized herein. The Navy organizational structure for the execution of policies in training and education is complex and for the sake of brevity will not be discussed herein.

1. Undergraduate Policies

There now exist twelve programs through which personnel are procured and commissioned as officers in the U.S. Navy. [34] Each program has its own prerequisites, qualification path and general policies. However, all commissioning paths must achieve the same goal expressed in the Secretary of the Navy's Statement of Policy on Graduate Education.

> "We must have an officer establishment which, in its entirety, is a corps of individuals, possessed of the demeanor, dedication, and requisite professional knowledge to ensure that the Nation's sea power contributes its maximum to our national security." [35]

In order to achieve this, all procurement paths have been required to place ever-increasing emphasis on each new officer's qualification to pursue graduate education. With the exception of Limited Duty Officer and Warrant Officer programs all officers now being commissioned must possess at least a baccalaureate degree.

2. Graduate Policies

The policy of the Department of Defense toward military officer graduate education is stated as follows: [35]

a. Officer positions where graduate education is essential for optimum performance of duty must be validated to require such officers.

b. Military personnel who have received fully-funded graduate level education benefits must be utilized to the extent practicable in these validated positions.

c. Quota requirements for fully-funded graduate education are to be based upon the validated positions.

d. All military personnel acquiring career-related graduate level education through Service-sponsored activities or through any other means, including off-duty programs, must be considered as potential assets in programming training requirements.

The policy of DOD further states that the Military Departments will:

a. In determining requirements for fully-funded graduate education, give careful consideration to the experience acquired by officers which may reduce or eliminate the requirements for formal educational programs.

b. Make the most effective use of short courses and off-duty education programs to fulfill their requirements, prior to validating positions as requiring graduate education.

c. Make maximum use of educational programs established by civilian educational institutions if they satisfy Service needs or can be tailored by the Services to satisfy such needs, prior to the establishment of in-house programs peculiar to the Military Departments. [35]

Officer billets to be validated as requiring officer personnel with graduate level educations must meet any one of the following guidelines:

a. The primary duties of the incumbent can be optimally performed only by individuals possessing qualifications normally acquired only through graduate level education in a relevant field of study.

b. Positions which must be filled by individuals who are required to exert direct technical supervision over military and/or civilian personnel who are required to possess graduate level education.

c. Positions which for optimum effectiveness must be filled by individuals who possess knowledge of a specific field of study to permit effective staff planning, coordination, and command advisory functions. [35]

Policies relating to utilization of officers possessing graduate level education are as follows:

a. To receive fully-funded education an officer must agree in writing to serve a period on active duty equal to three times the length of the period of that education, but not to exceed four years.

b. Upon completing graduate level education an officer must serve one tour in a validated position as soon as practicable after completion of such education.

c. He must serve as many subsequent tours in validated positions as Service requirements and proper career development will permit. [35]

In addition to fully-funded graduate education all military officers are encouraged to increase their general education for increased command and staff responsibilities.

The Department of Defense policy is further amplified by the Secretary of the Navy policy statements. Significant points are that:

> a. "We must look forward to the day when the officer with graduate education and training will be the rule rather than the exception." [35]
>
> c. "Advanced education, properly applied, will not only enhance an officer's performance, but is sure to become one of the vital stepping stones of his professional career." [35]
>
> c. "It is only by having sufficient numbers of such officers (having graduate education) that we can gain the necessary flexibility to enable us to continue the assignment of officers to a variety of duty." [35]

It should be noted that in the above policy statements the term "graduate level education" is used rather than terms which specifically indicate the awarding of an advanced degree (e.g., M.S., M.A., or Ph.D.). This allows for situations in which a commensurate graduate level of education is completed but, for some reason--academic attainment or otherwise--a degree is not awarded. [27]

In the past decade an increasing number of officers have pursued studies through the doctorate level in selected technical fields to enhance their capabilities, particularly in research and development positions.

Stated policy is that a limited number of exceptionally competent officers may be afforded an opportunity for study to the doctorate level in fields consistent with the needs of the Navy and if compatible with their career pattern. A normal maximum time which may be allotted for such study is four years. [36]

In the Navy the number of officers requiring a given graduate level of achievement is computed based upon the number of positions identified requiring incumbents having that qualification. That is, the number of officers possessing a particular combination of P-code, designator and grade should be 2.5 times the number of billets requiring officers of those qualifications. [30] Quotas for graduate level programs are computed based upon this factor and other complex manpower requirements projection techniques.

Officers are normally limited to attending a fully-funded graduate program in only one curriculum. Furthermore, officers who have obtained a master's degree in a given area are not allowed to participate in a program which would award an additional master's degree in the same or a closely allied academic area. [36]

B. TRAINING VS. EDUCATION

The distinction between training and education continues to be confusing. One philosophical method of separating the two was put forth by former-Secretary of the Navy, Paul Nitze, as follows:

> "It is essential to make a sharp distinction between training and education. On the one hand we must ensure that our professional training is adequate to meet our estimates of service needs--meaning billets. On the other hand, we must ensure the continued and long-term intellectual vitality of the Navy officer corps in dealing with a future which we can only vaguely foresee. This is the purpose of education. It is not to be measured by billets but by people. Training has to do with our tasks today; education, with the future." [37]

C. WARFARE SUBCATEGORY SPECIALIZATION

Whereas all previous policies noted herein have been most general, that is, they apply equally to all line officer categories of both the restricted and the unrestricted line; the Chief of Naval Operations, Admiral Elmo R. Zumwalt, recently made a policy statement of more limited applicability. On 9 July 1971, his statement on specialization within the various warfare subcategories (ASW, AAW, EW, SOSUS, Training, etc.) was issued. [21] Admiral Zumwalt stated that "there is an acute need for the talents of a specialist with concentrated education, training and experience in the warfare subcategories to meet certain critical requirements afloat and ashore." [21] Most of these billets require "an officer whose background combines both operational and technical or managerial experience." [21]

The most critical need for such an officer was seen to exist in the surface warfare specialty. Within the submarine and aviation communities, officers have become more specialized within the subcategories: submarine officers in nuclear power engineering or strategic weapons

systems; aviators in ASW or attack aircraft, for example. This specialization has simply not dominated career patterns for surface warfare officers. To adjust to the situation and to recognize realities, a "spectrum approach" [21] to officer career development was formulated. This approach will allow URL officers to have "various mixes of operational and managerial experience concentrated in certain subcategories of naval warfare." [21] The "spectrum" refers to the spread of officer experience from highly specialized to very generalized and all mixes in between. CNO policy is that "both the generalist and the specialist are essential in our operating forces" and "either...may command any of our operating units." [21] The intent is that "officers coming up through various career paths will have an equal opportunity to reach flag rank." [21]

D. TRAINING

A concise statement of Navy policies for the training of officers is much more difficult to lay down. Training facilities are widely scattered and are often directed toward fulfilling objectives which are quite limited in both content and time. It is perhaps sufficient to simply define the types of training rather than attempting to enumerate the policies. There are three recognized categories of formal officer training administered by the Navy. They are:

1. Officer Professional Courses: These programs are designed for the general professional development of officers and are not peculiar to any particular officer skill. Included are courses such as those offered

by the various Service Colleges, the Naval Submarine School, and the Naval Destroyer School.

2. Officer Skill Courses: These courses are designed to train an officer in a particular skill or to enhance an officer's skill in a specialty. Included are courses at Fleet Training Centers, Fleet ASW and AAW Schools, Fleet Aviation Electronics Training Units, etc.

3. Functional Schools: These schools train both officers and enlisted personnel, often in a group or team situation, in the performance of specialized tasks or functions which are not normal to the rating training of enlisted personnel nor to the professional training of officers. This training would be performed in sites as in 2 above and often is directed toward weapons or systems of new or advanced design and which have not reached universal usage. [38]

APPENDIX E

OCEANOGRAPHIC PROGRAMS OF THE UNITED STATES

The U.S. Navy's involvement in the broad discipline defined as oceanography is most complex, cutting across normal organizational paths not only within the Navy itself but also within the Department of Defense and the Administration of the Federal government. It must be recognized that it is not possible simply to examine Navy oceanography as an in-house matter--particularly in light of increasing governmental centralization of policy direction and super-departmental apportionment of federal tax monies. The programs of the Navy must be examined as they interrelate with the national marine programs. With this in mind, the oceanographic programs and the agencies effecting their direction will be briefly outlined from the overall Federal Administration through to purely Navy programs.

A. THE NATIONAL OCEANOGRAPHIC PROGRAM

1. National Academy of Science-National Research Council

The National Academy of Science (NAS) was originally established by an act of Congress during the Presidency of Abraham Lincoln in 1863.[39] The National Research Council (NRC) was organized under the charter of NAS and has operated thusly in accordance with an Executive Order signed by President Woodrow Wilson in 1918. The National Academy of Science is considered a "quasi-official agency" working closely with the federal

government in the furtherance of science for the general welfare of the country. The National Research Council has become the principal operating agency of NAS and "facilitates the participation of a broader representation of scientists and technologists in carrying out its objectives." [39]

NAS was an early supporter of scientific research in oceanography, appointing a Committee on Oceanography in 1927. Subsequent to World War II, a second Committee on Oceanography was appointed in 1949. This committee conducted a study of requirements for oceanographic research, published in 1952. [40] In this report, the committee concluded that greater than one-half of the funds for scientific research in oceanography were provided by the Department of Defense. Furthermore, "every aspect of oceanography--physical, chemical, biological and geological has direct applications to military problems of underwater sound." [40] In 1957 a third committee on Oceanography (NASCO) was established which published a report entitled "Oceanography 1960-1970." This report had a great influence on the expansion of funding for Oceanography in the 1960's. [41]

In 1959, the Interagency Committee of the Federal Council for Science and Technology was formed. This committee coordinated annual plans and programs of the agencies at the federal level in the marine sciencies. This function was superseded by committees established by the Marine Resources and Engineering Development Act of 1966, which will be discussed below.

2. <u>National Science Foundation</u>

The National Science Foundation (NSF), established by act of Congress in 1950, has a fundamental purpose to strengthen research and education in the sciences in the United States. [39] This purpose is accomplished by: the development and dissemination of information on scientific resources and manpower; the awarding of grants and contracts to universities and non-profit institutions for scientific research; the awarding of graduate fellowships at educational institutions; the support of programs aimed at improving scientific education in the United States. [39]

The National Science Foundation has a significant program to strengthen research, education and training in oceanography and the exploitation of the marine environment. [39]

3. <u>Effective Use of the Sea</u>

In 1966, a most significant step was taken toward national, coordinated direction of marine programs with the publication of the report of the President's Science Advisory Committee, Panel on Oceanography. [42] The panel recognized the importance of the oceans to our national security and recommended a clear statement of national goals for ocean programs. The recommended ultimate objective of the national ocean program was "effective use of the sea by man for all purposes currently considered for the terrestrial environment: commerce; industry, recreation and settlement; as well as for knowledge and understanding." [42] The four specific goals were as follows:

a. Acquiring the ability to predict and ultimately control phenomena affecting the safety and economy of seagoing activities.

b. Undertaking measures required for fullest exploitation of resources represented by, in, and under the sea.

c. Utilizing the sea to enhance national security.

d. Pursuing scientific investigations for describing and understanding marine phenomena, processes and resources. [42]

In order to achieve these national goals it was necessary to clearly identify the role to be played by the Federal Government. The Panel recommended the following four Federal functions:

a. Enunciation of national policies concerning the marine interests of the United States.

b. Fostering of exploration, development and use of the oceans and their resources through establishment of appropriate financial, legal, regulatory, enforcement and advisory institutions and measures.

c. Promotion of description and prediction of the marine environment and development of capabilities for its modification.

d. To initiate, support, and encourage programs of education, training, and research and to provide technical services and facilities related to activities in pertinent sciences and technology. [42]

At the time of the report, the U.S. Navy was clearly involved as the principal federal functional agency in all four above areas. Particularly in the latter two areas, the Navy has historically provided the major funding impetus and direction at the national level. For example, in the

ten-year period 1963-1972 projected by the Interagency Committee on Oceanography, the Navy would have provided 36% of the total National Oceanographic Budget. [41] The National Science Foundation was a distant second with a projection of 22% of the National Oceanographic Budget. The Committee recognized that "the most urgent aspect of Federal involvement in ocean science and technology for the next 5 to 10 years" was related to "national security in the narrow, strictly military sense" and that the U.S. Navy was responsible for essentially all defense efforts involving the ocean environment. [41]

2. Marine Resources and Engineering Development Act of 1966

On 17 June 1966 the Congress of the United States enacted into law the "Marine Resources and Engineering Development Act of 1966" (P.L. 89-454). [43] This law declared national policies and objectives essentially similar to those recommended by the President's Science Advisory Committee, but further established federal machinery and reporting requirements to ensure continued Federal involvement in marine science affairs. The Act created the National Council on Marine Resources and Engineering Development in the Executive Office of the President. It was to be the Council's responsibility to plan and coordinate a comprehensive Federal program of marine science activity within the departments and agencies of the United States. Additionally a Commission on Marine Science, Engineering, and Resources was established under the President to develop a long-range plan for an adequate national oceanographic program to meet present and future national needs. This Commission was to

recommend a Government organizational plan with estimated costs to carry out national marine science programs in the oceans, on the Continental Shelf of the United States, in the Great Lakes and on the seabed and subsoils of waters adjacent to the coasts of the United States and islands comprising U.S. territory.

3. The Stratton Commission Report

The Commission on Marine Science, Engineering and Resources was appointed by President Johnson in early 1967 under the chairmanship of Julius A. Stratton, Chairman of the Ford Foundation. Their report entitled OUR NATION AND THE SEA, published 9 January 1969, recommended a governmental reorganization to implement the national ocean program. [43] A new civilian National Oceanic and Atmospheric Agency (NOAA) was recommended as the principal operative agency for the administration of the national marine and atmospheric programs. This agency was to be composed of the U.S. Coast Guard, the Environmental Science Services Administration (ESSA), the Bureau of Commercial Fisheries, part of the Bureau of Sport Fisheries and Wildlife, the National Sea Grant Program, the U.S. Lake Survey and the National Oceanographic Data Center (NODC). [43]

The Commission recommended that NOAA be established as an independent agency, similar to the Atomic Energy Commission, reporting directly to the President. The administration of NOAA was to be given the responsibility for coordinating the planning and execution of all Federal civil marine and atmospheric programs related to its central function.

An advisory committee, appointed by the President from outside the Federal government, would be established to advise the administrator of NOAA and to act as a "watchdog" committee for the President and Congress on the achievement of national objectives. This committee was called the National Advisory Committee for the Oceans (NACO). [43]

The Stratton Commission recommended the establishment of several National Projects to be federally funded and administered by NOAA. These projects were in line with achieving national program goals. These projects and their recommended 10-year funding are summarized in Table VIII. [44]

Table VIII. Recommended National Projects Under NOAA

PROJECT	10-year Funding
TEST FACILITIES AND RANGES	$ 500,000,000
CONTINENTAL SHELF LABORATORIES	500,000,000
LAKE RESTORATION PROJECT	175,000,000
PILOT BUOY NETWORK	85,000,000
20,000 FT. EXPLORATION SUBMERSIBLE	285,000,000
CONTINENTAL SHELF NUCLEAR PLANT *	230,000,000
FEASIBILITY STUDIES FOR FUTURE PROJECTS	100,000,000
TOTAL	$1,875,000,000

* Jointly with Atomic Energy Commission

4. National Oceanic and Atmospheric Administration

The report of the Stratton Commission was not acted upon until July 1970 when President Nixon sent Reorganization Plan 4 to Congress.

This Plan went into effect on 3 October 1970 and established NOAA, not as an independent agency, but rather as the National Oceanic and Atmospheric Administration within the Department of Commerce. [39] NOAA's administrator is Dr. Robert M. White, who was formerly the administrator of the Environmental Science Services Administration (ESSA). The mission of NOAA is:

a. To explore, map and chart the global oceans.

b. To translate new physical and biological knowledge into systems capable of assessing the sea's potential yield which the Nation and its industries can employ.

c. To manage, use and conserve these animal and mineral resources.

d. To monitor and predict the characteristics of the physical environment and the changes of the atmosphere, ocean, sun and solid earth, gravity and geomagnetism, and to warn against impending environmental hazards. To ease the human burden of hurricanes, tornadoes, floods, tsunamis and other destructive natural events.

e. To administer and direct the National Sea Grant Program for aquatic research, education and advisory services.

f. Develop a national data buoy system. [39]

5. Environmental Protection Agency

President Nixon then sent an additional Reorganization Plan to Congress which established an independent agency within the Executive Office of the President. Thereby, the Environmental Protection Agency

(EPA) was formed 2 December 1970 under the administration of William D. Ruckelshaus. [39] EPA was created to permit coordinated and effective governmental action to assure the protection of the environment by abating and controlling pollution on a systematic basis. EPA has research, monitoring, standard-setting, and enforcement activities which, when properly integrated, will provide for the treatment of the environment as a single interrelated system. [39]

6. National Advisory Committee on the Oceans and Atmosphere

Finally in mid-1971, Congress enacted legislation establishing the National Advisory Committee on the Oceans and Atmosphere. This committee of 21 members appointed by the President, will carry out the advisory and "watchdog" functions outlined by the Stratton Commission Report and will report annually to the President through the Secretary of Commerce. The first Chairman of the National Advisory Committee is Dr. William A. Nierenberg, Director of Scripps Institution of Oceanography.

APPENDIX F

NAVY OCEANOGRAPHIC PROGRAMS

A. BASIC ORGANIZATION

By definition the Naval Oceanographic Program "encompasses that body of science, technology, engineering, operations, and the personnel and facilities associated with each, which is essential primarily to explore and to lay the basis for exploitation of the ocean and its boundaries for Naval applications to enhance security and support other national objectives." [44]

The Director of the Naval Oceanographic Program is a Flag Officer designated since 1966 as the Oceanographer of the Navy. The Oceanographer reports directly to the Chief of Naval Operations and is under the policy direction of the Secretary of the Navy through the Assistant Secretary of the Navy (Research and Development). The mission of the Oceanographer is to exercise centralized authority, direction and control, including control of resources, in order to insure an integrated and effective Naval Oceanographic Program. [45]

To assist in his assigned responsibilities the Oceanographer has four Assistant Oceanographers who are normally Flag Officers. These are:

1. The Chief of Naval Research, assigned additional duties as Assistant Oceanographer of the Navy for Ocean Science.

2. The Deputy Chief of Naval Material (Development), assigned

additional duties as Assistant Oceanographer of the Navy for Ocean Engineering and Development.

3. The Oceanographer of the Navy may designate an Assistant Oceanographer of the Navy for Oceanographic Operations. This billet has normally been vacant but is currently occupied by the Project Co-ordinator of the Deep Submergence Systems Project (Chief of Naval Operations, OP-03U). [46]

4. The Commander, Naval Weather Service Command, assigned additional duties as Assistant Oceanographer of the Navy for Environmental Prediction Services.

The administrative staff of the Oceanographer is assigned to the Office of the Oceanographer of the Navy (OCEANAV). The Oceanographic Operations function is assigned primarily to the Naval Oceanographic Office (NAVOCEANO). In the event the position of Assistant Oceanographer for Oceanographic Operations is vacant, the Commander of NAVOCEANO reports directly to the Oceanographer.

The basic organization to administer the Naval Oceanographic Program is depicted in Figure 2.

B. POLICY AND OBJECTIVES

The oceanographic policy of the Department of the Navy, simply stated, is to provide that oceanographic information and related technological base necessary for the Department of Defense to fulfill its assigned missions. [47]

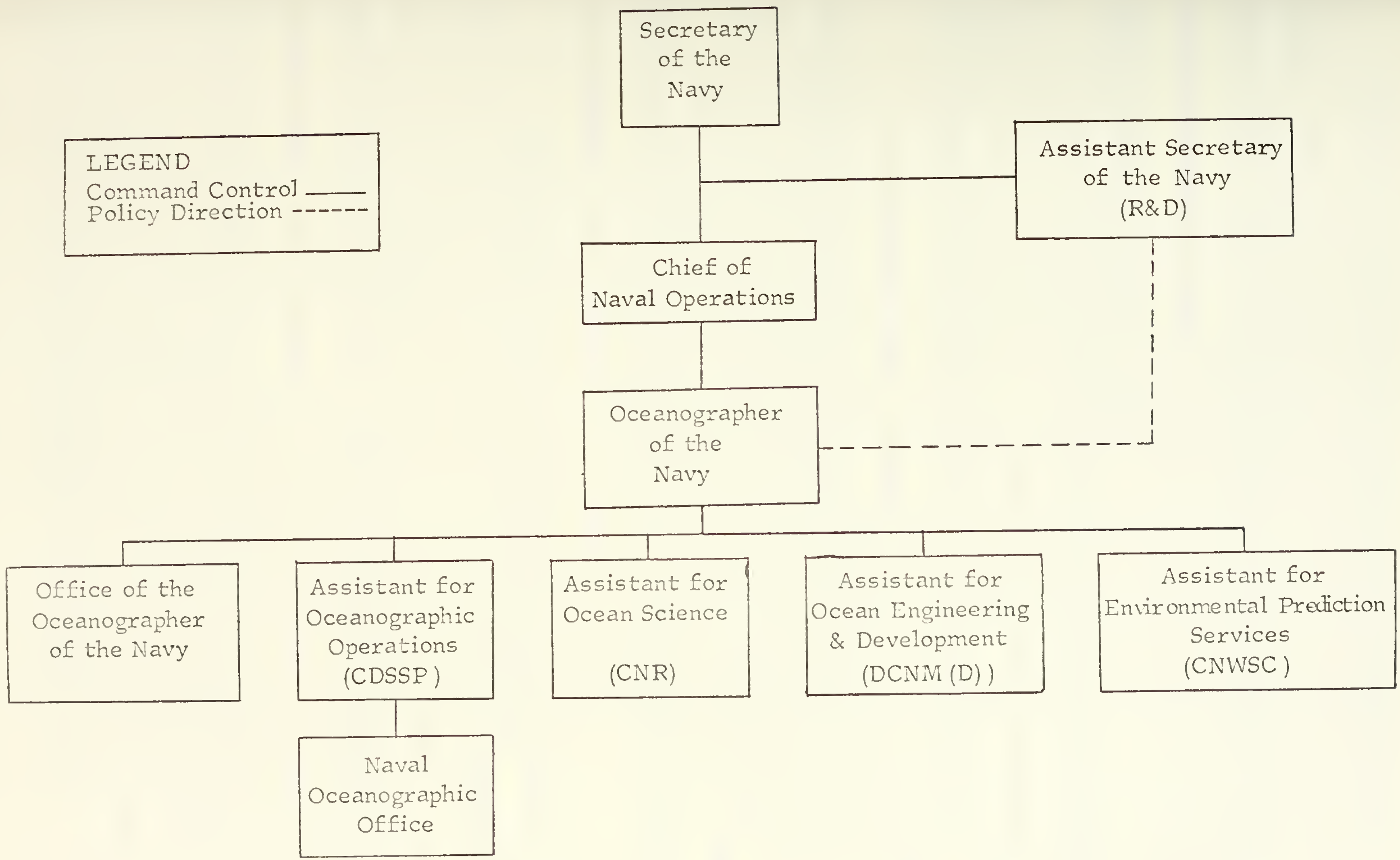

Figure 2. Naval Oceanographic Program Basic Organization [49]

The primary objectives of this program are the enhancement of military effectiveness through knowledge of ocean, coastal and seabed areas and the direct support of military system development, ship, vehicle and equipment design by solution of specific, immediate and long-range oceanographic problems. [47]

It is in the secondary objectives of the Naval Oceanographic Program that the ties to the National Oceanographic Program become apparent. The secondary objectives (Ancillary Benefits to National Effort) are:

1. To advance knowledge of all aspects of the ocean, coastal and seabed areas to permit and encourage successful exploitation of these areas for economic, scientific, social, political and prestige gains and

2. To cooperate in the preparation of plans for extending or developing international law concerning the ocean, coastal and seabed areas in the furtherance and protection of U.S. interests. [47]

These points, in effect, recognize the dominant position the Navy Oceanographic Program historically has occupied in the National Effort. If the Navy's oceanographic information is disseminated, benefit to other National programs is inevitable. Whereas the Navy's oceanographic programs must be totally responsive to military requirements, the obligation to secondarily support the non-military objectives of the National Oceanographic Program is fully recognized. The Navy's position is that the most economical approach to meeting many National objectives is the limited expansion of Navy programs and facilities where possible. [47]

The form and manner of Navy cooperation with the National Oceanographic Programs administered by NOAA and EPA remain unclear at this time. It must be assumed that trends toward detailed budgetary scrutiny and more centralized direction of programs in response to national priorities will continue. From this point of view it would seem inevitable that Navy oceanographic programs will become fully coordinated with National programs. Moreover, this eventuality is anticipated by the Navy in its statement of Oceanographic Policy:

> "Consistent with its own established oceanographic effort, the Navy will cooperate with any national organization devoted to the study of the total environment and/or any organization which attempts to provide a national focus to describe, understand and predict environmental phenomena and will also encourage the continued exchange of oceanographic data and knowledge with and between these organizations." [47]

Since NOAA and EPA are organizations clearly meeting this description, the Navy must become involved in their coordinated national programs. Initial moves have been made in this direction, such as the assignment of the former Oceanographer of the Navy, VADM W. W. Behrens, USN, as Associate Administrator for Interagency Relations within the NOAA organization in February 1972. Similarly, cooperation between EPA and the Navy has been facilitated by the creation of the Environmental Quality Division in the Office of the Oceanographer of the Navy. [46] It appears that other organizational changes of this nature will continue as NOAA and EPA sort out their early organizational and functional difficulties and clearly establish means by which National Programs are to be coordinated.

C. PROGRAM ORGANIZATION

A capsule description of all facets of the Navy's programs in oceanography is difficult. These programs involve numerous disciplines in science and technology--their unifying aspect being their application to Navy problems involving the ocean environment. Beyond their tenuous identification with scientific or technological disciplines, Navy programs become identified by their support role for a wide range of warfare missions and capabilities, none of which is related to a single academic discipline. Navy programs are categorized according to the titles of the four Assistant Oceanographers. Programs are divided into Ocean Science, Oceanographic Operations, Ocean Engineering and Development, and Environmental Prediction. As will be shown, these programs in many cases utilize the same facilities and personnel to accomplish missions related to several of these program categories.

Before further description of missions and organizational relationships, a quote from a previous study will be inserted here which is helpful in maintaining the proper perspective on Navy Oceanography. In the report of the Navy's Role in the Exploitation of the Ocean (Project BLUE WATER) [48], it is asserted that:

> "Naval Oceanography is a support function. It does not develop detection systems but does enhance their performance. It does not develop weapons but does enhance their effectiveness, and its research and engineering may lead to unforeseen applications in weaponry."

All of the various projects in the Naval Oceanographic Program are in support of Navy capabilities and missions. The following mission areas and capabilities have been identified as dependent to some degree on oceanography: Antisubmarine Warfare; Undersea Warfare; Mining and Mine Countermeasures; Amphibious Operations; Strategic Warfare; Surveillance; Striking Force Operations; Navigation; Reconnaissance and Intelligence; and Search, Rescue and Salvage. [48] It would seem safe to state that none of these areas could receive their total oceanographic support from a single organizational entity under the Oceanographer of the Navy. As a result the organizational relationships are quite complex and would appear in some respects to be at crossed-purposes with an efficient, functional program direction. The following sections will attempt to provide a concise exposition of the four major subdivisions of the Naval Oceanographic Program.

1. Ocean Science

The programs in Ocean Science are defined as efforts in research, development and technical guidance in support of operations to advance the knowledge of the physical, chemical, biological and geological nature of the world's oceans and their boundaries (surface and bottom). [44] Budgetary distinction is made between the Defense Research Sciences which involve fundamental research in the oceanic environment; and General surveillance and Navigation which entails applied research and exploratory development. [48]

The assignment of the Chief of Naval Research (CNR) as administrator of the Ocean Science Programs is organizationally sound since these programs form a part of the overall R&D programs which CNR oversees. Within his organization the Maury Center for Ocean Science, a functional division of the Naval Research Laboratory, provides the central research and development group in Ocean Sciences. The managers of the various related programs throughout the Shore Establishment form the Maury Center Coordinating Council of Ocean Sciences. These programs ranging from basic research through advanced development, involve various mixes of underwater acoustics, marine geology and geophysics, physical oceanography, biological oceanography, chemical oceanography and instrument development. These programs are supported through the Office of Naval Research and the Naval Research Laboratory, the Naval Ships Systems Command, the Naval Ordnance Systems Command, the Naval Facilities Engineering Command and the Naval Oceanographic Office. In addition to these in-house agencies of the Navy, the Chief of Naval Research annually contracts for research and development at roughly 100 universities, foundations and industrial laboratories. [48] A complete description of these programs is beyond the scope of this study. Figure 3 outlines the organization of the Ocean Science Program as it relates to Navy Research and Development Facilities.

2. <u>Ocean Engineering and Development</u>

Ocean Engineering and Development programs of the Navy encompass those major development projects vital to the successful

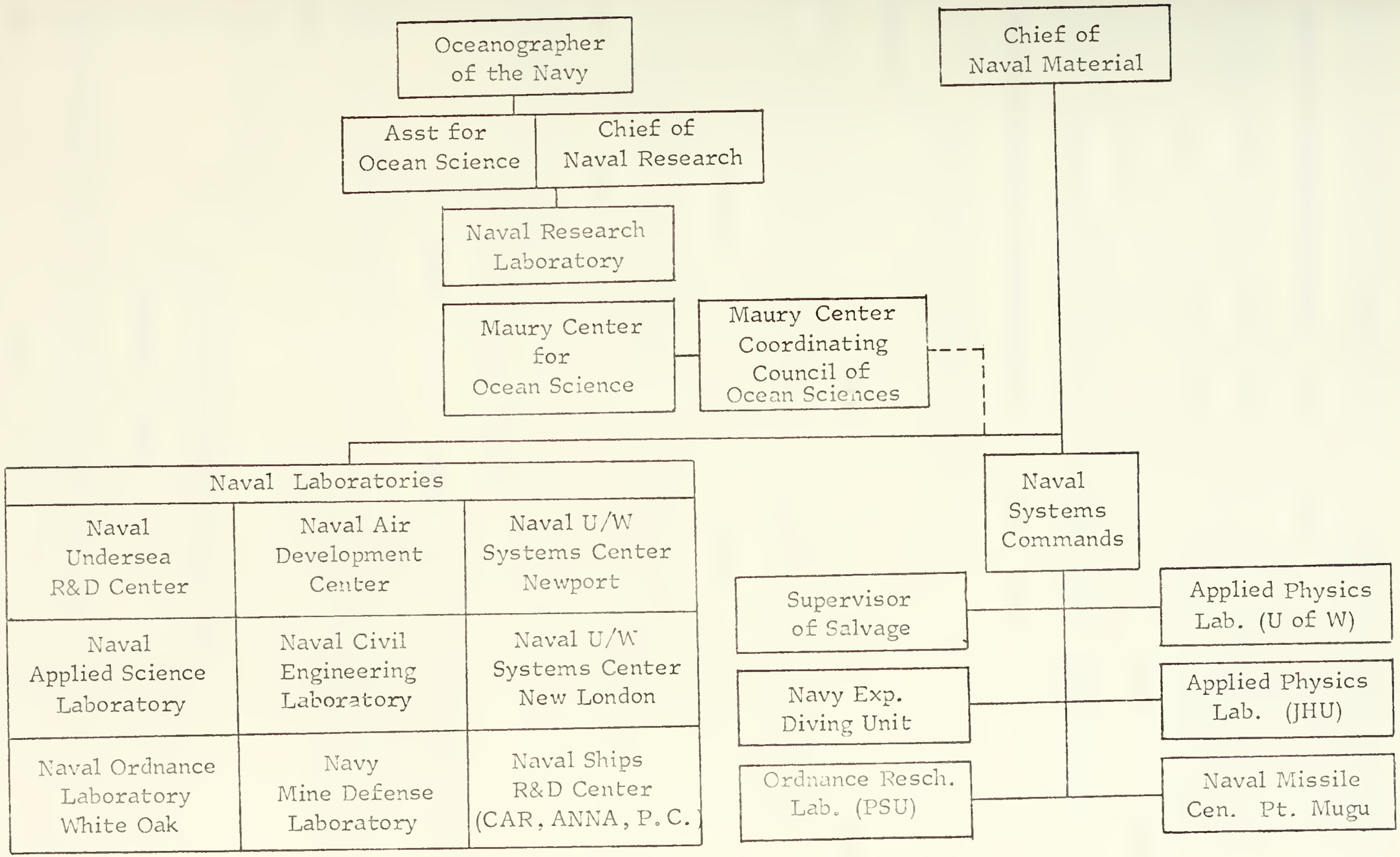

Figure 3. Ocean Science Program Organization. [49]

functioning of Navy activities beneath the sea surface. [49] Development programs in undersea search, rescue, salvage, and construction; as well as development in environmental prediction and oceanographic survey, are under the cognizance of the Assistant Oceanographer, the Deputy Chief of Naval Material (Development). [50] The majority of the funds managed in the execution of these programs is from the RDT&E appropriation category (Research and Development, Test and Evaluation). [48]

Ocean engineering technologies have been categorized into seven major areas. Each of these major areas may be further subdivided into many purer disciplines of science and technology; however, the major heading conveys adequately the disciplines involved and will suffice for this study. The categories are: materials and structural design; energy conversion and machinery; sensors, navigation, control, and communications; diver support; environmental prediction and oceanographic survey; acoustic oceanography; and sea floor engineering. [50]

a. Deep Submergence Program

The principal program within Ocean Engineering and Development is the Deep Submergence Program, which is further subdivided into the Deep Ocean Technology (DOT) Project and the Deep Submergence Systems Project (DSSP).

(1) <u>Deep Ocean Technology (DOT) Project</u>

This project coordinates, under the Chief of Naval Development, advanced development efforts in deep ocean weapons systems with the objective of providing viable technological options for undersea

weapons development in the future. [51] Funded development is proceeding in the areas of vehicle design and propulsion, sea floor structural design and installation, and materials for the deep ocean, as examples.

(2) Deep Submergence Systems Project (DSSP).

The Project Manager of DSSP reports to the Chief of Naval Material, through the Commander, Naval Ship's Systems Command. This complicates organizational relationships within the Naval Oceanographic Programs considerably. Within DSSP there are several subdivisions, as follows:

a) Submarine Location and Rescue. This project, now approaching an operational status, involves the capability to rapidly deploy a Deep Submergence Rescue Vehicle (DSRV) anywhere in the world to rescue a distressed submarine. This system consists of the submergence vehicle, supporting aircraft, nuclear submarines as rescue support platforms, catamaran hulled submarine rescue and salvage ships (ASR) and a Distressed Submarine Location System.

b) Large Object Salvage System (LOSS). The object of this project is to recover large objects, including disabled submarine hulls, from ocean depths to 850 feet. The LOSS system is supported by DSRV, the ASR and portions of the Man-in-the-Sea effort.

c) Man-in-the-Sea. This project involves the development of diver work systems to sustain extended, effective, operational diving on the continental shelf areas to depths of 850 feet.

d) The DSSP Manager also exercises management control over two separate projects which are not funded as a part of the Deep Submergence Program. These are the Deep Submergence Search Vehicle (DSSV) project and the NR-1 project. The former is the development of a deep submergency vehicle to conduct search, location and recovery of objects smaller than 10 tons in weight to a depth of 20,000 feet. The latter is an operational development project investigating application of nuclear power propulsion to an oceanographic research submersible.

(3) Other Projects

The Deep Submergence Program involves other projects not included in either DOT or DSSP. These are: the Deep Ocean Search Vehicle (DOSV) project; the Location Aid Device (LAD) project; and advanced bio-medical development in support of Man-in-the Sea. The DOSV project funds advanced research and development utilizing existing submersibles. The LAD project assists in the location of lost weapons and other small objects from the ocean floor.

b. Advanced Devlopment Programs

The bulk of the Ocean Engineering and Development Programs have been included in the Deep Submergence Programs discussed above. However, several efforts in advanced development are separate from DSP and should be mentioned. These are: acoustics development for ASW surveillance; oceanographic instrumentation development; oceanographic prediction development; and development in mapping, charting and geodesy.[48]

c. Organization in Ocean Engineering and Development

As in the Ocean Science Programs, virtually every Navy laboratory is involved in Ocean Engineering and Development Programs to some extent. (This is indicative of the diverse disciplines of science and technology encompassed by these programs.) Only the higher level management chain differs (Figure 4).

3. Oceanographic Operations

The Navy Oceanographic Operations Programs provide oceanographic data, services and operational support including hydrographic mapping, charting, and geodetic activities; and the technical support of operations including underwater search and rescue, recovery, salvage, emplacements, and facilities. [44] The Naval Oceanographic Office (NAVOCEANO) is the principal agency in the execution of these programs, employing about 3000 civilian managers, scientists, engineers and technicians, both ashore and afloat.

NAVOCEANO, under the Command of a Navy Captain, RL 1820, maintains the equipment, facilities and manpower to collect, process, analyze and store all manner of oceanographic, hydrographic and geophysical data and to provide direct support to the Fleet and the Merchant Marine. This support is in the form of charts, atlases and publications of tactical and strategic use to the Navy and which provide navigational aid to all mariners. NAVOCEANO was designated the Navy Hydrographic Office until 1962 and has been under the Office of the Oceanographer of the Navy

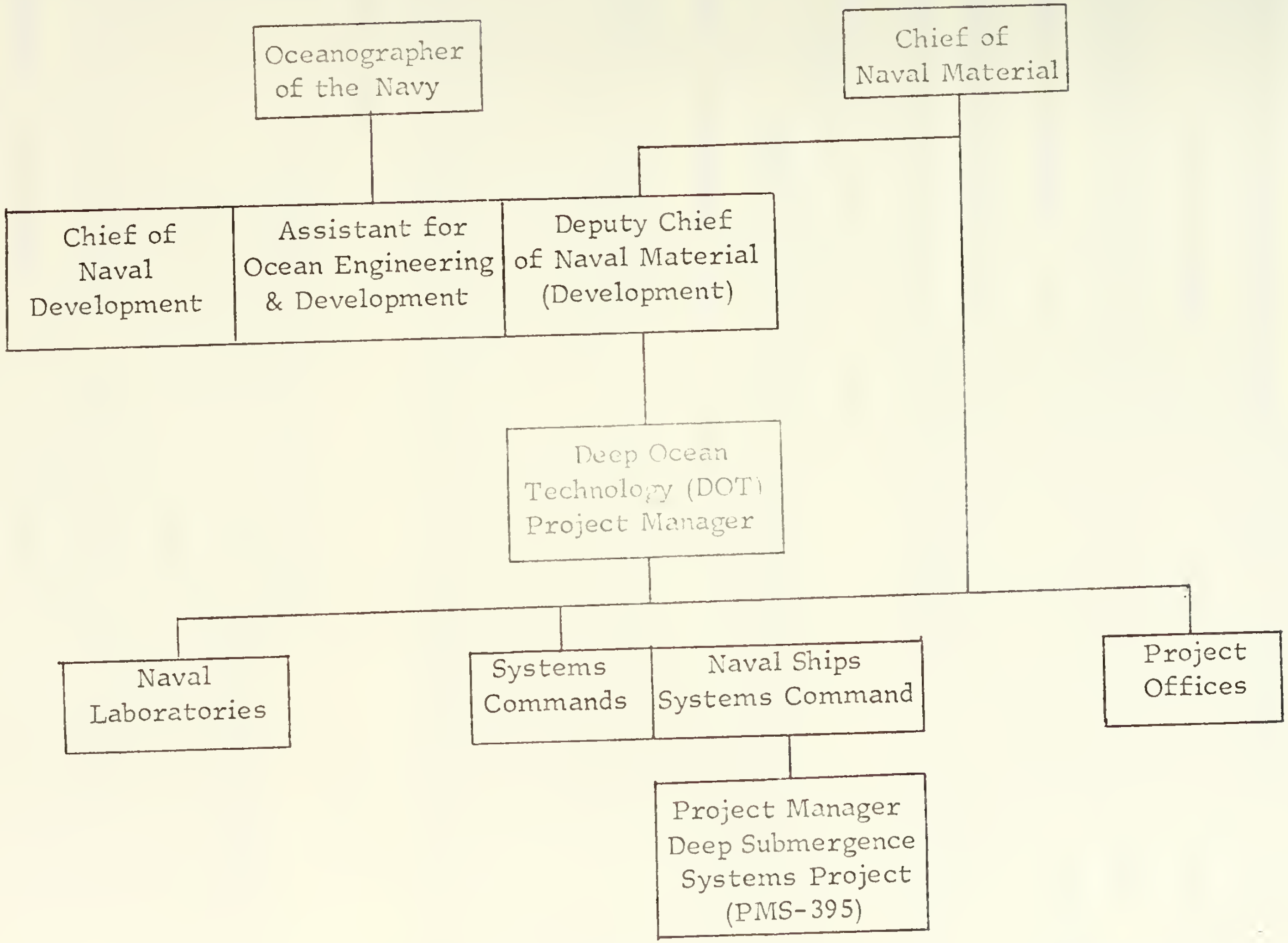

Figure 4. Ocean Engineering and Development Program Organization. [51]

since 1967. [52] The Ocean Science, Ocean Engineering and Development, and Environmental Prediction Services programs all depend heavily upon the support of the Oceanographic Office which funds the research and survey vessels used in the technical support of their projects. [48]

The Oceanographic Operations Program can be subdivided into two principal categories which account for nearly all of their funds. These are Mapping, Charting and Geodesy; and Oceanography. The Defense Intelligence Agency until recently has been charged by DOD Directive 5105.27 of 21 November 1962 with the coordination of all DOD efforts in Mapping, Charting and Geodesy.

Organizational changes are in progress at the time of this writing which are centered around the formation of a joint-Service Defense Mapping Agency. This agency will consolidate the mapping and charting functions of the three military departments under a common director who will report to the Secretary of Defense through the Joint Chiefs of Staff. The effects of this consolidation on the functions of NAVOCEANO have not been clarified as yet.

a. Mapping, Charting, and Geodesy

The Oceanographic Programs in this area are diverse and involve arts and skills as well as the application of the latest breakthroughs in science and technology. Nautical Charts, Port and Harbor Charts, Approach and Coastal Charts, and Sailing Charts are produced in fulfillment of statutory requirements originally laid on the Naval Hydrographic Office. [52] These charts are for the general usage of the Navy and the

Merchant Marine. Also for general usage are special publications such as Sailing Directions, Light Lists and other H.O. (Hydrographic Office) publications for navigational purposes. Products for military purposes include the special intelligence publications of the Defense Intelligence Agency, aeronautical charts, charts for amphibious operations and minesweeping, detailed bathymetric charts and targeting charts. This production is derived from extensive ocean and geodetic survey capability as follows: hydrographic survey, bathymetric survey, photographic survey both shipboard and airborne, airborne magnetic survey (Project Magnet), gravity survey and geodetic survey. [52] In-depth examination of these efforts is, unfortunately beyond the scope of this study. Furthermore, the full implication of organizational changes are not known at this time.

b. Oceanography

The oceanography programs of NAVOCEANO are mission-oriented in that their products are in direct support of the warfare and mission areas of the Navy. Ocean surveys provide comprehensive information on strategic ocean areas and a data base for use in the design and development of ASW/USW hardware. [52] The Deep Ocean Survey provides data on the oceanographic parameters which affect the operation of advanced sonar and strategic systems. Inshore environmental surveys provide data in support of planning for amphibious and mine warfare operations. Ocean bottom surveys facilitate planning and conducting search, rescue

and salvage operations. [52] Each of these surveys utilizes basic oceanographic data properly applied to meet the Navy's needs.

Products of oceanographic data distributed to the Fleet include: National Intelligence Survey publications, Mine Warfare Pilots, and Oceanographic Manuals and Atlases. [52] The purpose of many of these products is the support of antisubmarine and undersea strategic warfare. The tremendous influence of many oceanic features upon the behavior of underwate sound is not fully understood. Further, the totally inadequate knowledge of ocean parameters in all areas of the world ocean coupled with the economic and political necessity of keeping our ocean life-lines intact throughout the world places the importance of the Ocean Operations Programs in the proper perspective. A well-directed, efficient organization responding to the military requirements of the Navy and the Department of Defense is absolutely essential.

It was previously stated that the Naval Oceanographic Office supports other programs through funding for the operation of oceanographic research and survey ships. NAVOCEANO also provides funding for various operational prediction services within the Naval Weather Service Command, for advanced education for naval officers, and professional education for the civilian employees of NAVOCEANO. [52]

4. Environmental Prediction Services

This final division of the Naval Oceanographic Program is still officially included within the Oceanographic Operations Programs. [44] The fact remains that Environmental Prediction Services have been

provided historically by an organization separate from the Naval Oceanographic Office. Only since 1969 has the Commander, Naval Weather Service Command, performed additional duties as Assistant Oceanographer. This justified treatment here as a separate and distinct Naval Oceanographic Program.

The primarily shore-based organization of the Naval Weather Service Command is charged with providing the Fleet a variety of environmental services. These include (in addition to meteorological analyses and forecasts which will not be discussed) synoptic oceanographic analyses and forecasts; tailored products--analyses and forecasts prepared for environmental effects upon specific sensor systems; and oceanographic outlooks for specific areas. Thse products are in the form of charts and numerical and textual formats; and use both subjective (manual) and objective (computer) techniques. [53] The following products are routinely distributed to the Fleet by the Fleet Weather Centrals [53] :

1. Oceanographic Outlook
2. Sea Condition Forecast (Wind Wave or Combined Sea State)
3. ASRAP (Acoustic Sensor Range Prediction) Passive Propagation Loss Profiles
4. ASRAP Active Sonar Ranges
5. SHARPS (Ship, Helicopter Acoustic Range Prediction System)
6. Magnetic Storm Disturbance Forecast
7. SUBRAP (Submarine Range Prediction, under evaluation) [54]
8. SORAP (Sonar Range Prediction, under evaluation) [54]

a. Organization in Environmental Prediction

The organization for producing and disseminating environmental prediction services is that of the Naval Weather Service. The principal element of the Naval Environmental Data Network (NEDN) is the Fleet Numerical Weather Central (FNWC), Monterey, California, which maintains data bases and develops the computer programs for many of the automated products. [53] Meteorological and oceanographic data is gathered from sources worldwide to provide for the products distributed via the NEDN. This network includes the Fleet Weather Centrals, the subordinate Fleet Weather Facilities (FWF's) and Naval Weather Service Environmental Detachments (NWSED's). The Fleet Weather Centrals distribute data directly to Fleet units and to their subordinate activities in the NEDN. The FWF's and NWSED's modify and tailor some products as well as raw data for Fleet units in their area of responsibility. [53] Figure 5 depicts the organization of the Naval Environmental Data Network. This organization lies immediately beneath the Assistant Oceanographer for Environmental Prediction Services/Commander, Naval Weather Service Command, depicted in Figure 2.

5. Summary of Involvement in Navy Oceanographic Program

The preceding sections have not attempted to discuss in detail the involvement of the Navy and civilian laboratories and research institutions in Navy Oceanographic Programs. Table IX has been prepared as a summary of contracted R&D efforts in Navy laboratories and principal

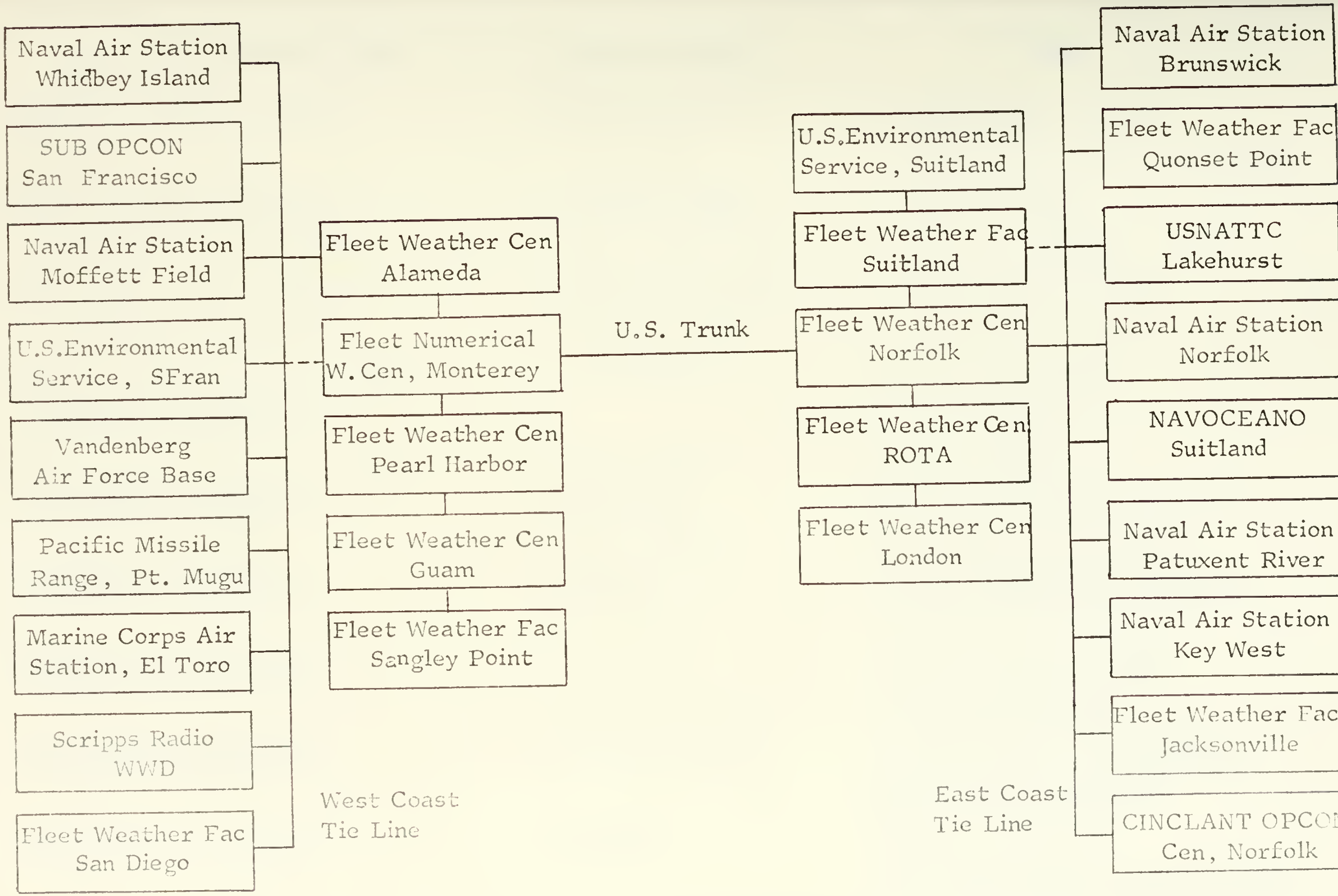

Figure 5. The Naval Environmental Data Network (NEDN). [53]

LABORATORY/INSTITUTION	AREAS OF STUDY
Naval Oceanographic Office Suitland, Maryland	1,2,3,4,5,6,7,17, 18,23,25,26
Naval Research Laboratory Washington (Maury Center)	1,3,4,5,7,9,10, 14,15,17,18,22,27
Naval Undersea R&D Center San Diego and other Sites	1,2,4,5,6,7,11,12, 13,15,18,19,21,22
Naval Underwater Systems Center Newport, Rhode Island	1,6,7,8,9,22
Naval Underwater Systems Center New London Laboratory	1,4,5,7,8,15, 17,19,20,21
Navy Ship R&D Center Carderock, Maryland	3,8,10,13,15, 18,21,22
Navy Ship R&D Laboratory Panama City, Florida	1,6,7,8,20
Navy Ship R&D Laboratory Annapolis, Maryland	14,15,17,19,21,22
Naval Ordnance Laboratory White Oak, Maryland	1,7,8,12

KEY

1. Underwater Acoustics
2. Bathymetry
3. Marine Chemistry/Geochemistry
4. Marine Biology
5. Marine Geology/Geophysics
6. Sea Floor Studies
7. Physical Oceanography
8. Ocean Waves
9. Air-Sea Interraction
10. Instrumentation
11. Arctic Studies
12. Underwater Optics
13. Drag Reduction
14. Ocean Structural Material
15. Undersea Structures
16. Foundations/Anchorages
17. Ocean Engineering Effects
18. Site Selection/Survey
19. Undersea Life Support
20. Diver-Related Study
21. Vehicles/Weapons
22. Remote Testing/Ranges
23. Environmental Forecasting
24. Pollutant Dispersion
25. Data Processing
26. Ocean Survey
27. Radioisotopes/Trace Elements

Table IX. Summary of Navy and Civilian Laboratory Contracted Study in Oceanography [48,49,50,51,52]

LABORATORY/INSTITUTION	AREAS OF STUDY	KEY
Naval Air Development Center Warminster, Pennsylvania	1,7	
Naval Civil Engineering Laboratory Port Hueneme, California	4,6,14,15,16,17, 18,19,20,21,22	
Naval Applied Science Laboratory	4,14,16,17,19,21,22	
Naval Mine Defense Laboratory Panama City, Florida	1,8,14,16,19,20	
Naval Postgraduate School Monterey, California	1,3,4,6,7,8, 9,11,12,23	
Naval Weapons Center China Lake, California	6,12,15,19,21	
Applied Physics Laboratory (Univ. of Washington)	1,8,12,22	
Chesapeake Bay Institute (Johns Hopkins University)	1,3,7,8,12,23	
Hudson Laboratories (Columbia University)	1,3,5,7	

Table IX (Continued) Summary of Navy and Civilian Laboratory Contracted Study in Oceanography [48,49,50,51,52]

LABORATORY/INSTITUTION	AREAS OF STUDY	KEY
Institute of Marine Sciences (University of Miami)	3,5,7,9,10	
Lamont-Doherty Geophysical Observatory (Columbia University)	1,2,5,6,11,26	
Massachusetts Institute of Technology	1,3,5,8,10, 12,15,23	
Narragansett Marine Laboratory (University of Rhode Island)	1,3,6,7,24,27	
New York University	7,8,9,23	
Ordnance Research Laboratory (Pennsylvania State Univ.)	1,7,21	
Oregon State University	1,3,5,7,9,23	
Scripps Institution of Oceanography (University of California, S. D.)	1,3,5,6,7,8,9, 10,21,25,27	
Texas A&M University	1,3,5,6,7,9, 10,22,23	
University of Alaska	3,6,7,9,11	

Table IX (Continued) Summary of Navy and Civilian Laboratory Contracted Study in Oceanography [48,49,50, 51,52]

LABORATORY/INSTITUTION	AREAS OF STUDY	KEY
University of Hawaii	5,7	
University of Washington	3,4,5,7,11,23	
Woods Hole Oceanographic Institution	1,2,3,4,5,6,7, 8,9,10,23,25,26	

Table IX. (Continued) Summary of Navy and Civilian Laboratory Contracted Study in Oceanography [48,49,50, 51,52]

civilian institutions to aid in determining the educational requirements of officers administering these programs and contracts. This by no means is intended to represent the total effort of these organizations but is an attempt to concisely summarize contracted participation in support of the Naval Oceanographic Program. The identification of contract areas by discipline or technology is somewhat arbitrary but is meant to be descriptive to both the general reader and the academician.

APPENDIX G

EXISTING OFFICER EDUCATION AND TRAINING IN OCEANOGRAPHY

From the outset it must be realized that only recently has oceanography been recognized as a discipline meriting the establishment of a separate university department. The pioneer academic institutions studying the oceans were established off-campus and association with university systems came at a later date (e.g., Scripps Institution of Oceanography and Woods Hole Oceanographic Institution). It was not until late in the 1940's that universities began to establish Departments of Oceanography on their campuses. In more recent years there has been a rapid expansion in the involvement of universities and colleges in oceanography. Still most universities consider oceanography as an interdisciplinary study which one undertakes only at the graduate level after a firm baccalaureate base is established in a more traditional discipline (mathematics, physics, chemistry, etc.). Although the Navy has for many years been the leader in supporting the research programs of these institutions, (and through research sponsorship has spurred academic programs), the establishment of continuing quotas for oceanographic education of its officers has not come about until the past decade.

Appendix F indicates the breadth and depth of the Navy's involvement in oceanographic programs. This Appendix will examine existing officer education and training curricula in Oceanography. Those curricula

taught at Navy-operated schools and educational institutions must be considered tailored to meet the requirements for officers of the Navy in compliance with stated policies. However, the Navy cannot hope to exercise direct control over the undergraduate education of all officers entering the Navy. Nevertheless, it must be assumed that the educational attainment of any officer can be recorded and may be considered as one significant accomplishment in his overall career development.

A. UNDERGRADUATE EDUCATION

As previously stated, all officers now receiving commissions in the Line of the Navy are required to have obtained a baccalaureate degree. Some fourteen civilian colleges and universities now offer baccalaureate degrees in oceanography or ocean engineering. Of these, only the University of Washington could provide Service inputs with baccalaureate oceanographic degrees through the Naval Reserve Officer Training Corps (NROTC). The Navy does not attempt to dictate the curriculum choice of NROTC students and therefore it would be impossible to expect any constant annual input of officers with oceanography baccalaureate degrees through NROTC programs. Similarly, inputs of these officers through Officer Candidate School and Aviation Officer Candidate Programs cannot be forecast.

The colleges and universities listed in Table X presently have baccalaureate programs in oceanography as indicated [55] and, when commissioned, their graduates should be considered as possible manpower assets of the Naval Oceanographic Program.

Table X. Baccalaureate Programs in Oceanography/Ocean Engineering

COLLEGE/UNIVERSITY	DEGREE OFFERED
The Catholic University of America	B.S.M.E. (Ocean Engineering Option)
University of Delaware	B.C.E. (Ocean Engineering Specialization)
Florida Atlantic University	B.S.E. (Ocean Engineering)
Florida Institute of Technology	B.S. (Physical Oceanography)
The George Washington University	B.S. (Oceanography)
Gulf Coast Technical Institute Mississippi State University	B. S. (Eng. Technology (Marine Construction Technology)
Humboldt State College, California	B.S. (Oceanography)
Long Island University (Southampton)	B.A. (Marine Science)
Massachusetts Institute of Technology	B.S. (Naval Architecture & Ocean Engineering)
City University of New York	B.S. (Oceanography)
The Maritime College of the State University of New York*	B.S. (Meteorology and Oceanography)
New York University	B.S. (Meteorology and Oceanography)
San Jose State College, California	B.S. (Oceanography Option)
U.S. Coast Guard Academy	B.S. (Oceanography & Ocean Engineering)
U.S. Naval Academy	B.S. (Oceanography) B.S. (Ocean Engineering)
U.S. Naval Postgraduate School	B.S. (Oceanography)
University of Washington	B.A. (Oceanography) B.S. (Oceanography) B.S. (Engineering Area with Specialization in Ocean Engineering)

* Eligible graduates may be commissioned Ensign, USNR

1. U.S. Naval Academy Curricula

The U.S. Naval Academy now has well established Bachelor of Science curricula with major and minor area study in oceanography and ocean engineering. A significant number of Midshipmen have elected to study in these disciplines (Table XI). [56]

Table XI. U.S. Naval Academy Midshipmen in Oceanographic Curricula

Graduating Class	Oceanography Minor	Oceanography Major	Ocean Engineering Major
1966	0	20	0
1967	0	13	0
1968	20	2	0
1969	39	5	0
1970	0	68	0
1971	0	100	18
1972	0	128	15
1973	0	141	57
1974	0	163	102

These students are subject to Navy policy guidance with respect to curriculum and Service choice and consequently their availability for the period of their obligated active service can be projected with relative assurance.

The Naval Academy programs appear to be balanced, general curricula in oceanography and ocean engineering which would provide a firm basis for future graduate study. Quite adequate course time is alloted for

mathematics, physics and chemistry to qualify for admission to future graduate level study in all technical curricula presently offered at the Naval Postgraduate School. Figures 6 and 7 present the Naval Academy curricula in Oceanography and Ocean Engineering and a breakdown of the course time by area. [56]

2. Bachelor of Science (Oceanography) at the Naval Postgraduate School

The desirability of baccalaureate level education and the opportunity to pursue it, needs promoting amongst that community of officers, including limited duty and warrant officers, with operational experience in oceanography-related fields. These officers and warrant officers have developed technical expertise through years of experience, usually in somewhat restricted fields (sonar maintenance and operation, electronics, aerography, etc.). It would seem profitable to broaden their experience with baccalaureate level education, in oceanography, so that they might comprehend more fully the influence of the environment upon the performance of equipments in which they are technically competent.

To date only a few officers, principally in the aviation warfare specialty, have completed their B.S. in Oceanography at the Naval Postgraduate School. A few more are enrolled in this major program at this time.

B. GRADUATE EDUCATION IN OCEANOGRAPHY AND OCEAN ENGINEERING

Naval officers have been afforded the opportunity to pursue fully-funded graduate education in oceanography only since 1954. From 1954 to

Figure 6. United States Naval Academy Bachelor of Science (Oceanography) [56]

Academic Year	Semester One	Sem. Hrs. Credit	Semester Two	Sem. Hrs. Credit
4/c	Fundamentals of Naval Science	4	Engineering and Weapons Systems	3
	Composition and Literature I	3	Composition and Literature II	3
	Calculus I	4	Calculus II	4
	Introduction to Computers	2	Principles of Chemistry II	4
	Principles of Chemistry I	4	Physical Geology	4
	Sem. Total	17	Sem. Total	18
3/c	Navigation I	4	Navigation II	4
	Engineering Physics I	4	Naval Engineering I	4
	Humanities & S.S. Elective	3	Engineering Physics II	4
	Calculus III	3	General Meteorology	3
	General Biology	4	Differential Equations	4
	Sem. Total	18	Sem. Total	19
2/c	Shipboard Weapons	3	Operations and Tactics	3
	Naval Engineering II	4	Psychology and Leadership	3
	Naval Electricity	4	Naval Electronics	4
	General Oceanography	4	Humanities Elective	3
	Essentials of Fluid Dynamics	3	Environmental Dynamics	3
			Thermostatics	3
	Sem. Total	18	Sem. Total	19
1/c	Military Law	3	History of Seapower	3
	Humanities & S.S. Elective	3	Weapons Systems Engineering	4
	Humanities & S.S. Elective	3	Humanities & S.S. Elective	3
	Oceanographic Applications	4	Oceanography Elective	3-4
	Oceanography Elective	3-4	Oceanography Elective	3-4
	Sem. Total	16-17	Sem. Total	16-18

Course Area Summary	Semester Hours
Professional	50
Humanities and Social Science	21
Mathematics	17
Basic Sciences	30
Major	23-26
Curriculum Total	141-144

Figure 7. United States Naval Academy
Bachelor of Science (Ocean Engineering) [56]

Academic Year	Semester One	Sem. Hrs. Credit	Semester Two	Sem. Hrs. Credit
4/c	Fundamentals of Naval Science	4	Engineering and Weapons Systems	3
	Composition and Literature I	3	Composition and Literature II	3
	Calculus I	4	Calculus II	4
	Humanities & S.S. Elective	3	Engineering Physics I	4
	Chemistry for Engineers	4	Introduction to Computers	2
	Sem. Total	18	Sem. Total	16
3/c	Navigation I	4	Navigation II	4
	Engineering Mechanics I	4	Engineering Mechanics II	3
	Electricity and Magnetism I	4	Engineering Materials	3
	Calculus III	3	Humanities & S.S. Elective	3
	Linear Algebra & Probability	4	Differential Equations	4
			Major Elective	2
	Sem. Total	19	Sem. Total	19
2/c	Shipboard Weapons	3	Operations and Tactics	3
	Solid Mechanics	4	Psychology and Leadership	3
	Thermodynamics	4	Fluid Dynamics	4
	Introduction to Electronic Science & Applications I	4	Introduction to Electronic Science & Applications II	4
	Introduction to Oceanography	3	Humanities & S.S. Elective	3
			Principles of Ocean Engineering	3
	Sem. Total	18	Sem. Total	20

Academic Year	Semester One	Sem. Hrs. Credit	Semester Two	Sem. Hrs. Credit
1/c	Military Law	3	History of Seapower	3
	Humanities & S.S. Elective	3	Free Elective	3
	Science Elective	3	Control Systems and Weapons	4
	Ocean Engineering Mechanics	3	Humanities & S.S. Elective	3
	Underwater Acoustics & Sonar	3	Major Elective	4
	Major Elective	2		
	Sem. Total	17	Sem. Total	17

Course Area Summary	Semester Hours
Professional	30
Humanities & Social Sciences	21
Mathematics	21
Basic Sciences & Engineering	52
Major	20
Curriculum Total	144

1963, 31 officers attended the University of Washington (26) and Scripps Institution of Oceanography (5). [57] Input quotas were sporadic during that period and because of difficulties in academic attainment qualifications, about one-half of the officers attending University of Washington were unable to obtain degrees. From 1963 to 1971 the number of officers studying oceanography in civilian institutions increased significantly and new curricula were established at the Naval Postgraduate School. The number of participating civilian universities reached thirteen and the numbers of officers who attended each is summarized in Table XII. During 1971 the Oceanographer of the Navy suspended sponsorship of officers to programs of these universities.

Table XII. Naval Officers in Oceanography/Ocean Engineering at Civilian Universities [57]

University	Total Officers Who Attended	Officers on Board 1 Jan 72
University of Washington	49	3
Scripps Institution of Oceanography	14	2
University of Maine	12	0
Oregon State University	8	0
Texas A and M University	8	0
Massachusetts Institute of Technology	4	1
University of Rhode Island	3	3
University of Hawaii	1	0
Johns Hopkins University	2	1
Stanford University	1	0
Pennsylvania State University	1	1
University of Wisconsin	1	1
Catholic University	1	0
Totals	105	12

There are academic programs at civilian universities under other sponsorship which can be considered related to the Naval Oceanographic Programs. For example, the Naval Ships Systems Command sponsors officers for the Naval Construction and Engineering curriculum at the Massachusetts Institute of Technology, one option of which is Ocean Engineering. The Naval Facilities Engineering Command sponsors a curriculum in Deep Ocean Construction Engineering (Ocean Engineering) for Civil Engineer Corps officers at Texas A and M University, University of Hawaii or Massachusetts Institute of Technology. Finally, the related curriculum of Hydrographic Engineering or Geodesy is sponsored by the Oceanographer of the Navy at the Ohio State University.

1. Naval Postgraduate School Curricula

Curricula in Oceanography at the Naval Postgraduate School have evolved over the last decade from courses emphasizing oceanography within the Meteorology Department to a separate Department of Oceanography awarding the Master of Science degree. In 1963, the advanced Air-Ocean Environment curriculum was established to provide an officer with an equal mix of graduate level meteorology and oceanography. [58]

By establishment of this curriculum, recognition was given to the influence of the total environment upon naval systems and weapons performance. This program, under the sponsorship of the Commander, Naval Weather Service Command, graduated 56 officers before it was dis-established in 1965. This disestablishment was brought about principally since the Naval Weather Service which did not consider graduates qualified

to fulfill duties in either oceanography or meteorology without further training. Therefore to provide fully-qualified oceanographers, a full curriculum in Physical Oceanography was then established within the Department of Meteorology and Oceanography which provided the basis upon which curricula have developed, through the creation of the separate Department of Oceanography in 1968, to the present. The meteorology curricula continue to include significant courses in oceanography and air-sea interaction to allow graduates to carry out the environmental prediction missions of the Naval Weather Service Command. A program to award the Doctor of Philosophy in Oceanography is under development.

Three curricula of the Department of Oceanography will be examined in this Appendix:

a. Physical Oceanography, Curriculum 440 (1970 version), which represents a curriculum essentially similar to that studied by 174 graduates since 1966 (Figure 8).

b. Technology of Ocean Operations or Ocean Operations Option (1970 version) from which 16 officers have graduated between 1968 and 1971 and which has been suspended by the sponsor during 1971 (Figure 9).

c. Physical Oceanography, Curriculum 440 (1972 version), which is the revised curriculum commenced by 14 officers in September 1971. This new curriculum provides a common core for the first three quarters with that of Meteorology, Curriculum 372 (Figure 10).

Examination of these three curricula leads one to the conclusion that there exists little opportunity for the individual student to exercise his choice of electives. His program is laid out fully for two years. Students will actually far exceed the minimum department requirements for the Master of Science in Oceanography which are:

a. Previous Bachelor of Science degree with mathematics through differential equations and integral calculus, one year of college physics and one year of college chemistry.

b. Thirty-five quarter-hours of graduate oceanography with 15 quarter-hours above the 4000 level.

c. Electives approved by the Department of Oceanography.

d. An acceptable thesis.

For the Ocean Operations option, Figure 9, these minimum requirements have been modified to require only 30 quarter-hours of graduate courses in oceanography (12 above the 4000 level) and 10 quarter-hours of graduate mechanical engineering (8 above the 4000 level).

A further breakdown of the curricula is essential in order to accurately depict the programs in oceanography. Within the degree requirements of 35 quarter-hours the Oceanography Department has identified five basic core courses in oceanography which must be taught to all students to qualify for the awarding of the degree in oceanography. These courses constitute the departmental requirements and include: Descriptive

Physical Oceanography, Biological Oceanography, Chemical Oceanography, Geological Oceanography and Field Experience in Oceanography; a total of 19 quarter-hours.

All courses at the 1000 or 2000 undergraduate-level are considered prerequisites. These courses are primarily courses in mathematics and in the case of calculus and differential equations are a review of courses which are required to qualify students for admission to the Oceanography curriculum. Prerequisites account for 24-28 quarter-hours of the curriculum.

Beyond the prerequisites and the degree requirements, the sponsor effectively can specify the mix of courses he desires with the restriction that the degree requirement of 35 quarter-hours of graduate-level study (15 above 4000) must be met. The sponsor has seen fit to fully specify the curriculum each officer will complete with the exception of one elective.

a. Immediate Graduate Education Program

A very limited number of qualified graduates of the U.S. Naval Academy and Naval ROTC universities are annually afforded the opportunity to obtain their Master of Science degree. Their baccalaureate curriculum must have provided a sufficient basis to allow them to complete the minimum requirements for the M.S. degree in only one year. To date, 14 officers have completed this program in oceanography.

Figure 8.

Naval Postgraduate School
1970 Physical Oceanography Curriculum
Curriculum Number 440

First Quarter	Qtr. Hrs.	Second Quarter	Qtr. Hrs.
Calculus Review	4	Linear Algebra and Vector Analysis	4
Introduction to Meteorology	3	Differential Equations and Infinite Series	4
Meteorology for Oceanographers	2	Chemical Oceanography	4
Descriptive Oceanography	4	Introduction to Engineering Materials	4
Biological Oceanography	4.5		
Qtr. Total	17.5	Qtr. Total	16

Third Quarter		Fourth Quarter	
Numerical Methods and FORTRAN Programming	4	Geophysical Random Processes	5
Partial Differential Equations and Integral Transforms	4	Dynamical Oceanography II	4
		Oceanographic Instrumentation and Observations	3
Dynamical Oceanography I	4		
Geological Oceanography	4.5	Field Experience in Oceanography	2
Qtr. Total	16.5	Qtr. Total	14

Fifth Quarter		Sixth Quarter	
Physics of Sound in the Ocean	5	Elective	3
Numerical Methods for Partial Differential Equations	4.5	Sound in the Ocean	3
		Coastal Oceanography	4.5
		Polar Oceanography	3
Dynamical Oceanography III	3	Thesis	
Waves and Tides	4		
Qtr. Total	16.5	Qtr. Total	13.5

Figure 8. (Continued)

Seventh Quarter	Qtr. Hrs.	Eighth Quarter	Qtr. Hrs.
Ocean Wave Forecasting	3	Oceanographic Forecasting	3
Ocean Wave Forecasting Laboratory	3	Oceanographic Forecasting Laboratory	2
Air-Sea Interaction	3	Seminar in Oceanography	2
Thesis		Thesis	
Qtr. Total	9	Qtr. Total	7

Course Area Summary	Quarter Hours
Mathematics	24.5
Physics	5
Engineering	4
Meteorology	8
Oceanography	68.5
Curriculum Total	110.0

Figure 9. Naval Postgraduate School Ocean Operations Curriculum Curriculum 440 (OE Option)

First Quarter	Qtr. Hrs.	Second Quarter	Qtr. Hrs.
Calculus Review	4	Linear Algebra and Vector Analysis	4
Introduction to Meteorology	3	Differential Equations and Infinite Series	4
Meteorology for Oceanographers	2	Chemical Oceanography	4
Descriptive Oceanography	4	Geological Oceanography	4.5
Introduction to Engineering Materials	4		
Qtr. Total	17	Qtr. Total	16.5

Third Quarter		Fourth Quarter	
Mechanics I	4	Numerical Methods and FORTRAN Programming	4
Biological Oceanography	4.5	Marine Fouling	1.5
Partial Differential Equations and Integral Transforms	4	Field Experience in Oceanography	2
Ocean Operations I	3.5	Oceanographic Instrumentation and Observation	3
		Instruments and Equipment for Ocean Operations	5.5
Qtr. Total	16	Qtr. Total	16

Fifth Quarter		Sixth Quarter	
Mechanics of Solids I	4	Mechanics of Solids II	4
Fluid Mechanics	5	Ocean Operations II	3.5
Waves and Tides	4	Hydrodynamics	4
Physical Properties of Marine Sediments	3.5	Coastal Oceanography	4.5
		Thesis	
Qtr. Total	16.5	Qtr. Total	16

Seventh Quarter	Qtr. Hrs.	Eighth Quarter	Qtr. Hrs.
Corrosion	4	Mechanics of Solids III	4 *
Dynamical Oceanography	3	Sound in the Ocean	3
Elective	3	Seminar in Ocean Operations	2
Thesis		Thesis	
Qtr. Total	10	Qtr. Total	9

* May be utilized for additional thesis work, if required.

Course Area Summary	Quarter Hours
Mathematics	20
Engineering	34.5-38.5
Meteorology	5
Oceanography/Ocean Engineering	53.5
Curriculum Total	113 - 117

Figure 10. Naval Postgraduate School 1972 Physical Oceanography Curriculum 440

First Quarter	Qtr. Hrs.
Faculty Seminar	1
Vector Analysis and Linear Algebra	4
Introduction to Meteorology	4
Introduction to Meteorological Analysis	2
Introduction to Oceanography	4
Differential Equations and Infinite Series	4
Qtr. Total	19

Second Quarter	Qtr. Hrs.
Climatology and Statistics	3
Principles of Measurement	4
Geophysical Thermodynamics	4
Numerical Analysis	4
Partial Differential Equations	4
Qtr Total	19

Third Quarter	
Geophysical Random Processes	3.5
Descriptive Physical Oceanography	4
Introductory Geophysical Fluid Dynamics	4
Meteorological Analysis	3
Meteorological Analysis Laboratory	3
Qtr. Total	17.5

Fourth Quarter	
Geological Oceanography	4.5
Ocean Circulation	4
Weather Elements	4
Weather Elements Forecasting	3
Qtr. Total	15.5

Fifth Quarter	
Biological Oceanography	4.5
Scientific Cruise Experience	2
Air-Sea Interaction	4
Waves and Tides	4
Elective	4
Qtr. Total	18.5

Sixth Quarter	
Field Experience in Oceanography *	
Polar Oceanography *	4
Chemical Oceanography	4
Sound in the Ocean	3
Thesis	
Qtr. Total	11

Seventh Quarter	Qtr. Hrs.	Eight Quarter	Qtr. Hrs.
Coastal Oceanography	3.5	Acoustical Forecasting	3
Ocean Wave Forecasting	3	Acoustical Forecasting Laboratory	2
Ocean Wave Forecasting Laboratory	2	Case Studies in Environmental Support	2
Thesis		Seminar in Oceanography	2
		Thesis	
Qtr. Total	8.5	Qtr. Total	9

* Option of either Field Experience or Polar Oceanography

Course Area Summary	Quarter Hours
Mathematics	16
Physics	4
Meteorology	38
Oceanography	60
Curriculum Total	118

2. Present Students in Graduate Oceanography Curricula at NPS

There are currently 74 Naval officers enrolled in graduate curricula in the Department of Oceanography at the Naval Postgraduate School. These are divided as follows: a) 41 in Physical Oceanography (1970 curriculum), b) 14 in Physical Oceanography (1972 curriculum), c) 13 in Technology of Ocean Operations, and d) 6 in the Immediate Graduate Education Program. On 24 March 1972, 15 Physical Oceanographers and 6 "Ocean Technologists" will complete these curricula.

3. Oceanography in Other Curricula at NPS

In addition to the above curricula, the Department of Oceanography provides instruction in oceanography for several other interdisciplinary curricula on a regular basis. The courses and the serviced curriculum are listed below.

Curriculum	OC Courses	
Bachelor of Science Engineering Science (461)	OC 2110	Introduction to Oceanography
Engineering Science (460)	OC 2110	Introduction to Oceanography
Underwater Physics Systems (535)	OC 3221	Descriptive Physical Oceanography
	OC 4260	Sound in the Ocean
Ocean Mechanical Engineering (570)	OC 3221	Descriptive Physical Oceanography
	OC 3250	Dynamical Oceanography
	OC 3801	Ocean Operations I
	OC 4802	Ocean Operations II

C. OFFICER PROFESSIONAL MANPOWER IN OCEANOGRAPHY

Upon completion of graduate level education programs in Oceanography officers are coded for identification and to allow retrieval by data processing

for future assignment to billets so-coded. Master's level education in oceanography results in assignment of P-code 8710; doctorate level is 8710D. Similarly, within the Geophysics area, meteorology is coded 8610 and hydrography is 8720. Billets which require officers with graduate level education in accordance with DOD and Navy policies have been identified for both Unrestricted Line Officers and Restricted Line Officers (SDO 1820). In general, billets for URL officers (8710P or 8710D) involve duties, primarily ashore, related to research management, antisubmarine warfare and training. RL officers in SDO category 1820 (8710P) are once again primarily in shore billets in program management, environmental prediction, intelligence, surveillance and training duties. Appendix I contains the latest available summary of billets for officers with advanced education in oceanography and hydrography. The following data concerning oceanography manpower assets and officer utilization is obtained from the Study on Oceanographic Support for ASW [2] performed by the Office of the Oceanographer of the Navy. The conclusions and recommendations of this study were partially summarized in Appendix C.

The following paragraphs and tables graphically demonstrate the status of officers who have received advanced education and/or specialty status in Oceanography. As in the Oceanographer's study, the division in the analysis between URL and RL will be maintained.

1. Unrestricted Line Officers (8710P or 8710D)

As Table XIII will show, there are a considerable number of officers who have completed graduate education in oceanography. From

numbers alone it would appear that 216 qualified officers to fill 55 existing billets would be entirely adequate. Unfortunately, the grade distribution is skewed toward qualified officers in the grade of Lieutenant Commander and billets in the grade of Lieutenant. If the guideline of 2.5 qualified officers per billet is applied, there are insufficient qualified officers in the grade of Lieutenant to fill the 25 existing billets.

Table XIII. URL P-coded Billets vs. URL P-coded Officers

Rank	P-coded Billets	P-coded Officers Available
CAPT	3	7
CDR	12	35
LCDR	15	139
LT	25	25
LTJG	0	6
ENS	0	4
Total	55	216

When these 55 billets are examined (Table XIV), it becomes apparent that with only five billets existing in the research category, there is little opportunity to infuse recent operational experience into the research and development portions of the Navy Oceanographic Program. Although a large percentage of the billets involve an operational role, twenty-two billets distributed throughout the Navy is a very small number of billets.

Table XIV. URL 8710 Billet Distribution by Function

Function		Billets	% of Total
Operational		22	40
Management/Administrative		7	13
Research		5	9
Training/Education		21	38
	Total	55	100

When these 55 billets are further categorized into being either afloat or ashore (Table XV), it becomes readily apparent that the opportunity for subspecialist oceanographers to serve in a P-coded billet in the Operating Forces is very small.

Table XV. URL 8710 Billet Distribution by Afloat/Ashore Commands

Rank	Total Billets	Afloat	% of Total (55)	Ashore	% of Total (55)
CAPT	3	0	0	3	5
CDR	12	3	5	9	16
LCDR	15	2	4	13	24
LT	25	6	11	19	35
Total	55	11	20	44	80

This is a somewhat distorted view, however, since it must be considered that an awareness of the ocean environment gained through graduate education will manifest itself in billets which have not been P-coded. As shown in Table XVI, only 9 P-coded sea billets exist in the ASW forces. It is a gross error to assume that only these 9 officer-oceanographers are contributing to the oceanographic support of ASW. In fact, all P-coded

officers and others with an enhanced awareness of the environmental variability in ASW problems contribute to the oceanographic support of ASW when serving at sea in ASW units and staffs.

Table XVI. URL 8710 Billets Associated with ASW

Rank	Total Billets	ASW Associated Afloat	ASW Associated Ashore	Percent
CAPT	3	0	0	0
CDR	12	1	7	67
LCDR	15	2	8	67
LT	25	6	19	100
	55	9	34	78% overall

An analysis of the grade distribution of 8710P officers (Table XVII) again demonstrates the tremendous bulge in the grade of Lieutenant Commander. On the surface this appears to signal poor quota control and grade requirements for officers entering the graduate programs. However, it must be borne in mind that these officers are at a level which will allow them to perform as commanding officers, executive officers or senior operational assistants in ASW surface ships, submarines, aircraft squadrons and associated staffs. If it can be demonstrated that their capabilities in these billets have, in fact, been enhanced by their educational experience, an entirely different light would be cast on the matter.

Table XVII. URL 8710 P-coded Officers by Rank

Rank		Number	% of Total
CAPT		7	3.3
CDR		35	16.2
LCDR		139	64.3
LT		25	11.6
LTJG		6	2.8
ENS		4	1.8
	Total	216	100.0

2. SDO 1820 Officers

The SDO category designated 1820, was established by the Chief of Naval Personnel in September 1969, following the submission of the report of the Waters Board, discussed in Appendix C. This Restricted Line community consists of two subdivisions--those with duties in oceanography and those in hydrography or hydrographic engineering. Table XVIII shows the structure of the officer assets and billets by rank.

Table XVIII. SDO 1820 Billets by Rank

Rank		Billets	Officers Available
CAPT		10	5
CDR		19	11
LCDR		35	26
LT		23	17
LTJG		38	3
ENS		4	10
	Total	129	72

This table gives a somewhat inflated picture of the community. The inclusion of Oceanographic Research and Research Watch Officer billets at Naval Facilities and student billets at the Naval Postgraduate School is dubious. In these billets officers do not perform duties strictly as an oceanography specialist. These billets have been established to provide a viable career pattern for those officers assigned to Naval Facilities in their initial assignment. A number more indicative of the billets for the "true 1820" specialist would be 83. Of these 83 billets, only 39 require master's level education in oceanography and 9 require master's level education in hydrography/hydrographic engineering (8720P). None of the billets listed in Appendix I requires doctorate level education. Tables XIX and XX summarize the rank distribution and educational attainment of the 72 SDO 1820 officers at the time of the OCEANAV study.

Table XIX. SDO 1820 Officers

Rank		Number	% of Total
CAPT		5	6.9
CDR		11	15.3
LCDR		26	36.1
LT		17	23.6
LTJG		3	4.2
ENS		10	13.9
	Total	72	100.0

Table XX. SDO 1820 Officer Educational Background

Level Completed	CAPT	CDR	LCDR	LT	LTJG	ENS	Sub-Total
Ph.D.	0	1	0	1	0	0	2
MS	2	6	23	9	1	1	42
PG	3	2	2	1	0	0	8
BS	0	2	1	6	2	9	20
Total	5	11	26	17	3	10	72

Education level:

1. BS - never attended a graduate school.
2. PG - graduate school, but no graduate degree.
3. MS - Master of Science degree.
4. Ph.D. - Doctor of Philosophy degree.

When the billets are analyzed by function, Table XXI, the paucity of billets involving research and development management is similar to that shown previously for URL Officers in oceanography. A large number of the billets described as "operational" are those at the Naval Facilities, whose assignment within the 1820 community is questionable.

Table XXI. SDO 1820 Billet Distribution by Function

Function	Billets	% of Total
Operational	66	51.2
Management/Administrative	42	32.6
Research	7	5.4
Training/Education	14	10.8
Total	129	100.0

An examination of 1820 billets by ashore or afloat categorization yields only 16 billets afloat, all of which are in ocean survey ships operated by the Military Sealift Command. There are no afloat billets which support the antisubmarine warfare forces of the Navy on a day-to-day, watch-to-watch basis.

Table XXII. SDO 1820 Billet Distribution by Afloat/Ashore Commands

Rank	Billets	Afloat	% of Total (129)	Ashore	% of Total (129)
CAPT	10	0	0	10	7.8
CDR	19	0	0	19	14.7
LCDR	35	5	3.9	30	23.3
LT	23	0	0	23	14.8
LTJG	38	11	8.5	27	20.9
ENS	4	0	0	4	3.1
Total	129	16	12.4	113	87.6

All SDO 1820 billets whose role is ASW support are ashore and only one such billet is for an oceanographer in the grade of Commander or above (Table XXIII). Ironically the 1820 officers, qualified by specialization, assignment consistency, and education to manage significant oceanographic programs in direct support of ASW have no billets at sea in which to perform these tasks.

Table XXIII. SDO 1820 Billets Associated with ASW

Rank	Total	ASW Associated Afloat	ASW Associated Ashore	Percent
CAPT	10	0	0	0
CDR	19	0	1	5
LCDR	35	0	13	37
LT	23	0	9	38
LTJG	38	0	27	71
ENS	4	0	4	100
	129	0	54	42% overall

It must be stated that this RL category represents a newly-established corps of officers whose potentiality and billet allowances have not been fully realized. However, it does not appear that recent billet reviews have significantly altered the billets toward increased emphasis on ASW support.

D. OFFICER TRAINING IN OCEANOGRAPHY

Fleet professional, functional and skill training in oceanography for officers, almost without exception forms the basis of courses in preparation for duties in antisubmarine of undersea warfare. To rely on acoustic detection and tracking, and the use of weapons which seek their target by acoustic energy requires a good understanding of underwater sound propagation and environmental effects upon that energy. This understanding of sound in the ocean is required whether the Fleet ASW/USW operator is in the surface, subsurface or aviation warfare category.

The organizational structure of Navy Training programs has recently been changed with the creation of the position of Chief of Naval Training and the restructuring of responsibility for training within the organization. This should not cause any radical changes in the content of the courses offered by individual training commands since they fulfill needs established by the Fleet. However, the new organization should provide a means of maintaining the currency of instructional techniques and could provide common training materials and aids to several commands where applicable. In this respect, applied oceanography training could benefit since basic needs are common in the surface, subsurface and aviation communities.

Existing oceanography training, with the exception of that conducted at the Naval War College and the Naval Oceanographic Office, is directed toward officers in a particular warfare specialty. At the Naval War College senior officers from all warfare categories of the Unrestricted Line, the Staff Corps and the Restricted Line receive advanced professional education which will not be discussed herein. The Naval Oceanographic Office provides general, comprehensive instruction in oceanography and hydrography which might more accurately be classified as packaged education, though no academic credit is gained by students. The NAVOCEANO courses will be discussed in later paragraphs. Briefly summarized, the topics taught in ASW/USW curricula, which shall be called "applied oceanography," are as follows [60] :

a) Fundamental physics of underwater sound.

b) The principles and methods by which sound is diminished in the sea.

c) Environmental factors contributing to sound losses in the sea.

d) The principles of scattering and reverberation.

e) Environmental factors contributing to scattering and reverberation.

f) Composition and temporal and spatial changes of the deep scattering layer.

g) Sound velocity in the sea and environmental factors affecting the sound velocity profile (wind, currents, internal waves, global heat budget, etc.).

h) Characteristics of the sound velocity profile in various water masses.

i) Environmental factors affecting sound ray refraction and reflection.

j) Environmental factors affecting the various modes of underwater sound propagation.

k) Sonar range prediction techniques and fleet environmental products of the Naval Weather Service Command.

1. Training for Surface Warfare Officers

For surface warfare officers (111X), training in oceanography as applied to the antisubmarine warfare problem is provided at five major sites.

The Fleet Sonar School, Key West, Florida, and the Fleet Antisubmarine Warfare School, San Diego, California, provide several courses for ASW Officers, ASW Deck Officers, and Commanding Officers and Executive Officers of ASW ships which for a considerable time have included topics in "applied oceanography." In recent years new equipments taking advantage of the several modes of sound propagation in the ocean have forced an increased time allotment for description of the environment, its processes and effects on sonar performance. As an example, Fleet Sonar School, Key West, recently revised their Antisubmarine Warfare Officer curriculum, J-2G-5365, increasing coverage of topics in the environmental aspects of ASW from 9 to 19 hours in an 8-week course. Throughout all ASW curricula this emphasis on environmental effects on ASW performance in other topics is inescapable. (Note: The officer training section of the Fleet Sonar School is being shifted from Key West, Florida, to Newport, Rhode Island.)

The Atlantic Fleet ASW Tactical School, Norfolk, Virginia, and its Pacific Fleet counterpart, the Tactical Training Group of Fleet ASW School, San Diego, provide additional training on the tactical employment of ASW Forces. At these sites instruction in environmental effects is somewhat more general and is allotted a briefer time in the curricula. Still, the same topics as above are emphasized toward the point of view of the ASW commander or staff officer.

The Naval Destroyer School, Newport, Rhode Island, has included these topics in the ASW Operations segment of the 6-months' curriculum

for destroyer heads of department and, in a compressed form, in five-week briefings for destroyer prospective commanding officers/executive officers. Prior to 1971, the environmental segment was taught by briefing teams from Fleet Weather Central, Norfolk, or Fleet Weather Facility, Quonset Point, Rhode Island. In late 1971, an officer P-coded 8710 was assigned to the Destroyer School and now performs this instruction. However, his billet is not P-coded.

Surface ship Combat Information Center Officers receive some environmental instruction in the ASW portions of the CIC Officer and the Antisubmarine Air Controller Courses conducted at the Naval Air Technical Training Center, Glynco, Georgia.

It is felt that mention should be made of other warfare subcategories which have training courses emphasizing oceanographic knowledge. Courses for mine warfare officers conducted at the Naval Mine Warfare School, Charleston, South Carolina, treat the environmental factors which must be considered in mining and mine countermeasures. Also the Naval Amphibious Schools at Little Creek, Virginia, and Coronado, California, discuss the environmental intelligence role of amphibious staff and shipboard officers in the efficient conduct of amphibious warfare.

2. Training for Submarine Warfare Officers

Submarine warfare officers (112X) receive instruction in similar topics of "applied oceanography" at the Naval Submarine School, Groton, Connecticut, and from the Submarine type commanders' staff in Pearl Harbor, Hawaii (PCO/PXO briefings).

For all submarine officers, contact with the oceanic environment is intimate and of constant concern. The covert nature of submerged operations dictates that submariners properly evaluate environmental factors to avoid detection and accomplish their mission. As a consequence of this mission dependence on environmental effects submarine officers as a general group are believed to have a firmer understanding of oceanography than surface officers, in general. As an example of the emphasis submarine officers place upon environmental or oceanographic effects; in course F-4B-010, Sonar Principles, conducted at the Naval Submarine School, a total of 19 hours are included in a two-week curriculum. In the Submarine Officer's Basic Course (SOBC, A-00-104), 43 hours of the 6-month curriculum concentrate on "applied oceanography."

3. <u>Training for Air Warfare Officers</u>

Air Warfare officers (13XX) through repeat tours in aircraft type (patrol; rotary and fixed wing antisubmarine warfare aircraft) may also develop a firmer grasp of environmental effects than surface warfare officers. These officers, particularly Naval Flight Officers qualified as Tactical Coordinator (TACCO), become de facto ASW specialists within the air warfare category.

The training courses attended by these officers follow a logical progression: basic antisumarine warfare courses prior to initial assignment to ASW air squadrons, continued instruction within operational squadrons,

and refresher courses on repeat tours through the Replacement Air Groups.

The Fleet Airborne Electronics Training Units at Norfolk, Virginia, and San Diego, California and their detachments carry out the basic instruction in "applied oceanography" for officers in Air ASW. The courses are divided between officers entering patrol squadrons (VP) and those being assigned to rotary and fixed wing antisubmarine squadrons (HS and VS) but the instruction is essentially similar. Refresher courses are also taught for officers in repeat tours in these squadrons. Additionally, the Replacement Air Groups, such as HS-10 and VP-31 conduct refresher courses including "applied oceanography."

In a typical curriculum taught at FAETUPAC, E-2D-056, Carrier Fixed Wing Antisubmarine Warfare Tactics, 21.5 hours is allotted to "applied oceanography" in a course of two weeks' duration.

4. Training at the Naval Oceanographic Office

The Naval Oceanographic Office offers three courses which include instruction in basic and applied oceanography. Although these courses are utilized primarily to instruct oceanographic or hydrographic officers of allied navies, the breadth and level of instruction is significant and should be analyzed in determining the Navy's ability and readiness to fulfill recognized needs for U.S. officer education and training in oceanography.

The three courses available at NAVOCEANO are as follows:

a. Hydrographic Engineering/Basic Oceanography

This 12-month course primarily stresses hydrographic engineering and geophysics. The last six weeks are devoted to a course in Basic Oceanography which is a prerequisite for the other two courses offered at NAVOCEANO. This Basic Oceanography course includes instruction in: underwater sound, ocean currents, tides, ocean waves, physical properties of sea water, basic statistics, marine biology, marine sedimentation, coastal geomorphology, seismology, and instrumentation and laboratory methods.

b. Basic/Applied Oceanography

This course applies the basic oceanography above to advanced analysis, forecasting and laboratory techniques in a 16-week program.

c. Anti-Submarine Warfare Environmental Prediction Services Program.

This 8-week program familiarizes students with ASWEPS prediction system theory and application. Prerequisites for this course are the 6-week Basic Oceanography and the 16-week Basic/Applied Oceanography courses. Topics covered include: data collection, isotach analysis, sea-surface temperature and layer depth analysis, sound channel analysis, oceanographic forecasting of waves and thermal structure, ocean current studies, biological influences, aircraft oceanography, and ship routing.

5. <u>Officer Correspondence Instruction in Oceanography</u>

At the present time two Navy correspondence training courses in oceanography are available from the Naval Correspondence Center in

Scotia, New York. These courses provide basic topics in oceanography and applied oceanography in ASW. They are designated as follows:

NAVPERS	10417-2	General Oceanography
NAVPERS	10418	Oceanography in ASW (CONFIDENTIAL)

APPENDIX H

ADDITIONAL QUALIFICATIONS DESIGNATION FOR ASW

A. EXPLANATION

The AQD code in sequence consists of a letter, a letter and a number. [22] Normally the first digit represents the major category such as Pilot, NFO, Surface Warfare, Naval Warfare, etc., and, except for Naval Warfare, is aligned with the designator. The second and third digits reflect the additional qualifications desired of the incumbent.

For ASW, the codes are as follows:

1st Digit	2nd Digit	3rd Digit
	A - ASW Qualified	1. Aviation
		2. Surface
		3. Submarine
A - Naval Warfare	B - ASW Technical Expert	4. Any
		5. SOSUS
		6. Aviation/SOSUS
		7. Surface/SOSUS
	C - ASW Operational Expert	8. Submarine/SOSUS

B. REQUIREMENTS FOR SPECIFIC AQDs for ASW

1. ASW Qualified (AA*)

a. AVIATION

(1) Be qualified as ASW Plane Commander or Tactical Coordinator.

b. SURFACE

(1) Successfully complete an ASW functional school of at least two weeks duration.

(2) Minimum one tour as ASW officer aboard ASW mission-oriented ship.

c. SUBMARINE — (1) Qualified in submarines.

d. ANY — (1) Qualified in any ASW category.

e. SOSUS — (1) Attendance at SOSUS training school.

f. AVIATION/SOSUS
- (1) Be aviation ASW qualified.
- (2) Minimum of one tour in a NAVFAC.

g. SURFACE/SOSUS
- (1) Be surface ASW qualified.
- (2) Minimum of one tour in a NAVFAC.

h. SUBMARINE/SOSUS
- (1) Be submarine ASW qualified.
- (2) Minimum of one tour in a NAVFAC.

2. ASW Technical Expert (AB*)

- (1) Be ASW qualified in one or more areas of paragraph B1
- (2) Postgraduate education in a technical curriculum related to ASW to include at least 3 hours Acoustics and 3 hours Oceanography.
- (3) Serve a second operational tour in type in an ASW related billet.
- (4) Postgraduate utilization tour in an ASW related billet.

3. ASW Operational Expert (AC*)

- (1) Be ASW qualified in one or more areas of paragraph 2a.

* Third digit will be determined in paragraph B.

(2) Serve a second operational tour in type in ASW related billet.

(3) Serve in a staff/shore tour in an ASW associated billet.

C. EXAMPLES

1. The AQD Code AA2 represents a billet requiring an officer who is Surface ASW Qualified.

2. The AQD Code AB3 represents a billet requiring an officer who is a Submarine ASW Technical Expert.

3. The AQD Code AC1 represents a billet requiring an officer who is an Aviation ASW Operational Expert.

4. The respective codes also identify officers with the respective level of expertise in ASW.

APPENDIX I

Included herein are the following tables:

Table XXIV. This table is a summary of existing billets for unrestricted line officers P-coded 8710. Table I has been coded to indicate the curriculum proposed in this study which will best qualify the officer for the duties of the particular billet.

Table XXV. This table is a summary of existing billets for the SDO 1820 officers (Geophysics/Oceanography). Note that in this table, billets are coded for graduate oceanographers (8710 P) and graduate hydrographers (8720P) ; and no code indicates graduate level education not specified. In this table, the new curriculum 440 (September 1971) offered at the Naval Postgraduate School applies to all billets presently coded (8710P). Several billets presently uncoded are recommended for P-coding and one billet is recommended for D-coding.

Table XXIV. URL Billets P-coded 8710 (Oceanography)

Billet Desig	Allowance	Activity Title	Rank	Billet Title
1120S	1	HQ NAVMATCOMD DC	CAPT	HD OCEAN ENG & DEV BR
1300A	1	CINCPACFLT	CAPT	HD AV PLN-PROG
1100*	1	OSD	CAPT	CHIEF ENVRN SCIENCES DIV
1100+	1	NAVUNSR&DCEN DGO	CDR	CHIEF STAFF-TECHNICAL
1120A	1	COMFIRSTFLT	CDR	ASW/UNDERSEA WARFARE
1100A	1	COMCRUDESLANT	CDR	ANTI-SUB WARFARE
1100+	1	NAVAL ACAD	CDR	HD NAV/OCEANO CMTE
1100A	1	LANTASW TACSCH	CDR	HEAD
1100A	1	SACLANT RESCHCEN	CDR	NAVAL ADVISOR
1100+	1	ONR WASH DC	CDR	PROJ OFF ARCTIC
1320A	1	OCEANGRAPHSYSLNT	CDR	OPERATIONS
1310A	1	OFF OCEANOGRAPHER	CDR	HEAD ASW BRANCH
1120A	1	OFF OCEANOGRAPHER	CDR	HEAD UNSEA WARFARE BRANCH
1120S	1	OFF OCEANOGRAPHER	CDR	HD ENGR & DEV PROG BR
1100S	1	OPNAV OP-03	CDR	OP-371E HD OPNS & READ SEC
1100S	1	OPNAV OP-06	LCDR	OP-601C1 CINCPAC PLANS
1120A	1	COMSUBPAC	LCDR	SPECIAL PROJECTS COORD
1120A	1	COMSUBPAC	LCDR	ASST TACT DEV & PCO INST
1100A	1	COMCRUDESPAC	LCDR	ASW TRNG-READINESS
1341A	1	HS 10	LCDR	ASW/OCEANOGRAPHY
1371A	1	VP 31	LCDR	TRNG COORDINATOR
1120+	1	NAVAL ACAD	LCDR	AIR OCEAN ENVIRON INSTR
1100+	1	NAVAL ACAD	LDCR	AIR OCEAN ENVIRON INSTR
1100S	1	NAVUNSR&DCEN DGO	LCDR	AST TECH-OCEAN SCI
1100S	1	NAV SHIPRESCHDEV	LCDR	OPERATIONS

Billet Desig	Allowance	Activity Title	Rank	Billet Title
1100A	1	COMOPTEVFOR	LCDR	AST DETECT & CLASS EVAL
1120A	1	PAC ELOPTEVFOSTF	LCDR	ASW DETECT/CLASSIFY SYS
1310*	1	FLTWTHRCEN ALMDA	LCDR	ENVIRONMENTAL FORECASTER
1100*	1	NAVWEASERVCOM DC	LCDR	HEAD ASW SPT/OCEANO BRANC
1100A	2	FLT SONAR SCH KE	LCDR	INSTR ASW TACT
1100A	1	ASW GROUP 2	LT	ASWEPS
1100A	1	ASW GROUP 4	LT	ASWEPS
1100A	1	ASW GROUP 5	LT	ASWEPS
1100A	1	COMCRUDESFLOT	LT	ASWEPS
1100A	1	COMCRUDESFLOT	LT	ASWEPS
1331A	1	VS 41	LT	ASW/GRND TRNG
1100A	1	CDESGRP LBEACH	LT	DESDEVGRU SPEC PROJ-ASW
1120A	1	FLTNUWTHCEN MONT	LT	SUBT ASW LIAISON
1370A	1	FAETU PAC	LT	OCEANOGRAPHER
1370A	1	FAETUPAC MOFFET	LT	OCEANOGRAPHER
1100A	1	FLT ASW SCH SAN	LT	SURF ASW TACT INSTR
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTASWSCH SD	LT	SURF ASW TACT INSTR
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTASWSCH SD	LT	SURF ASW TACT INSTR
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTASWSCH SD	LT	ASW OFFICER

Billet Desig	Allowance	Activity Title	Rank	Billet Title
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTASWSCH SD	LT	ASW OFFICER
1100A	1	FLTSONARSCH KWST	LT	INSTR ADV SONAR

KEY:

(1) A after Billet Designator indicates billet appropriate for graduate of "Oceanography-ASW" or "Oceanography-Acoustics" curricula.

(2) S after Billet Designator indicates billet appropriate for graduate of oceanography curriculum aimed toward "Technical Officers."

(3) + indicates billet which could be filled by graduate of either (1) or (2).

(4) Asterisk (*) indicates billet recommended for reallocation to SDO 1820 officer.

Table XXV . 1820 RL Billet Summary

Rank	Activity Title	Billet Title	P-coded	Allowance
CAPT	CINCPAC	CHIEF 51/01		1
CAPT	OFFICE OF OCEANOGRAPHER	CHIEF OF STAFF		1
CAPT	OFFICE OF OCEANOGRAPHER	MILITARY ASST TO SPEC DEP		1
CAPT	OFFICE OF OCEANOGRAPHER	ASST C/S ADMIN AND TRAINING	8710P	1
CAPT	OFFICE OF OCEANOGRAPHER	ASST C/S PLANS OPS & RDN		1
CAPT	OFFICE OF OCEANOGRAPHER	ASST C/S RDT&E		1
CAPT	NAVOCEANO SUITLAND	COMMANDER	8710P	1
CAPT	NAVOCEANO SUITLAND	DEPUTY COMMANDER PRODUCTION	8710P	1
CAPT	NAVOCEANO SUITLAND	DEPUTY COMMANDER SURVEYS	8710P	1
CAPT	DEFENSE INTEL AGENCY	CHIEF 36 DBA/001	8720P	1
CDR	TP&P QUAL			1
CDR	CINC US STRIKE COMMAND	HYDRO PLANS 07168		2
CDR *	COMUSNAVSO/COMFIFTEEN	OCEANOGRAPHER		1
CDR	HDQTRS US EUCOM	HYDROGRAPHER 40B/03		1
CDR	CINCPAC	HYDRO PROG OFF 51/03		1
CDR	OFFICE OF OCEANOGRAPHER	PLANS		1
CDR	OFFICE OF OCEANOGRAPHER	ASST C/S FINANCIAL MGMT	8720P	1
CDR	NAVOCEANO SUITLAND	DIRECTOR BUDGET DIVISION		1
CDR	NAVOCEANO SUITLAND	ADEP CMDR PROD	8720P	1
CDR	NAVOCEANO SUITLAND	DIRECTOR OPERATIONS OFFICE	8710P	1
CDR	NAVOCEANO SUITLAND	SCIENCE AND ENG PROG MG	8710P	1
CDR	NAVOCEANO SUITLAND	PLAN PROG MG	8710P	1
CDR	DEFENSE INTEL AGENCY	HYDRO PL/PR OFF 360CA/002	8720P	1
CDR *	OPNAV	OP-954C AST FOR DEPLOY SYS		1
CDR	NAV RESCH BR OFF BOSTON	OCEANO RESCH/SURV	8710P	1

Rank	Activity Title	Billet Title	P-coded	Allowance
CDR +	OFF NAV RESCH WASH	SPECIAL ASST OCEAN SCIENCE	8710P	1
CDR	STU IND COL ARM FOR WASH	STUDENT		3
CDR	POST GRAD SCH MONTEREY	INST	8710P	1
CDR	WAR COLLEGE NEWPORT	SUPV MARINE SCIENCES	8710P	1
LCDR	TP&P QUAL			1
LCDR	NAV UNSEA R&D CEN SDGO	AST TECH-OCEAN SCI	8710P	1
LCDR	COMASWFORLANT	OCEANOGRAPHIC/AST OCEAN	8710P	1
LCDR *	CINCPACFLT	MAPS CHARTS & GEODESY		1
LCDR *	FLT ASW SCH SAN DIEGO	SUR ASW TACT INSTR		1
LCDR	OFFICE OF OCEANOGRAPHER	ENVIRONMENTAL QUALITY PLANS	8710P	1
LCDR	NAVBROCEANO HONOLULU	OFFICER IN CHARGE		1
LCDR	NAVOCEANO SUITLAND	ENG DEPT	8710P	1
LCDR	NAVOCEANO SUITLAND	SHIP MAINT REP	8710P	1
LCDR	NAVOCEANO SUITLAND	DEPUTY DIR OPERATIONS OFFICE	8710P	1
LCDR	NRL OFF NAV RESCH WASH DC	ACOUSTICS R&D		1
LCDR *	NAVUNWATSYSCEN DET NLOND	OCEAN SURVEY		1
LCDR	OCEANOGRAPHIC UNIT 1	CO UNIT NO 1		1
LCDR	OCEANOGRAPHIC UNIT 2	CO UNIT NO 2		1
LCDR	OCEANOGRAPHIC UNIT 3	CO UNIT NO 3		1
LCDR	OCEANOGRAPHIC UNIT 4	CO UNIT NO 4		1
LCDR	OCEANOGRAPHIC UNIT 5	CO UNIT NO 5		1
LCDR	OCEANOGRAPHIC UNIT 6	CO UNIT NO 6		1
LCDR	OPER STUDY GRP WASH DC	PROJ OFF	8710P	1
LCDR	NAV RESCH BR OFF LONDON	MIL OCEAN OFF	8710P	1
LCDR	OFF.NAV RESCH WASH	PROJ OFF PHYSICAL OCEANO	8710P	1
LCDR	FLT WTHR CENT	OCEANOGRAPHER	8710P	1
LCDR	FLT WTHR CENT NORFOLK	OCEANOGRAPHER-OCEANO SVCS	8710P	1
LCDR	FLT WTHR CENT NORFOLK	ENVIRON FORECASTER	8710P	2
LCDR	FLT WTHR CENT GUAM	OCEANOGRAPHY OFFICER	8710P	1

Rank	Activity Title	Billet Title	P-coded	Allowance
LCDR	FLT WTHR CENT PEARL	OCEANO SERVICES OFFICER	8710P	1
LCDR	FLT WTHR CENT ROTA	OCEANO SERVICES OFFICER	8710P	1
LCDR	FLT NUMERWTHRCENT MONTEREY	OCEANOGRAPHER-DIV OFF	8710P	1
LCDR	STU WAR COLLEGE NEWPORT	STUDENT		1
LCDR *	NAVAL ACADEMY ANNAPOLIS	OCEANOGRAPHY INSTR		2
LCDR *	FLT SONAR SCH KEY WEST	INSTR - PHYSICS OF SOUND		1
LCDR	POST GRAD SCH MONTEREY	AST CURR OFF	8710P	1
LCDR	POST GRAD SCH MONTEREY	INST		1
LT	TP&P QUAL			1
LT	NAVBROCEANO RODMAN CZ	INC		1
LT	NAVBROCEANO NORFOLK	OFFICER IN CHARGE		1
LT	NAVBROCEANO SAIGON	OFFICER IN CHARGE		1
LT	NAVOCEANO SUITLAND	LANT OPS OFFICER	8710P	1
LT	NAVOCEANO SUITLAND	PAC OPS OFFICER		1
LT	NAVOCEANO SUITLAND	TAGS SURV COORD	8710P	1
LT	NAVOCEANO SUITLAND	TAGOR SURV COORD	8710P	1
LT	FAETUPAC MOFFETT DET	OCEANOGRAPHER	8710P	1
LT	NAVAL ADVISORY GRP USMACV	ADVISOR		1
LT	FLT WTHRCENT PEARL	ENVIRON FCSTR	8710P	1
LT *	NAV SCIEN TECH INTELCEN	OCEANOGRAPHIC ANAL		1
LT	NAV FLD OPINT OFF FT MEADE	OCEANO OPS ANAL	7210S	1
LT *	OCEANOGRAPHIC SYSTEM PAC	PLANS		1
LT	FLT WTHR CENT GUAM	ASW SERVICES OFFICER	8710P	1
LT	FLT WTHR CEN GUAM	OCEANOGRAPHY OFFICER	8710P	1
LT	FLT WTHR CENT ROTA	ENVIRON FCSTR	8710P	1
LT	FLT NUMERWTHRCENT MONTEREY	MET RSCH&DEV-DIV OFF	8710P	1
LT	STU POST GRADUATE SCHOOLS			1
LTJG	TP&P QUAL			1
LTJG	NAV PAC BERMUDA	RESRCH WATCH		1
LTJG	NAV FAC BERMUDA	OCEANOGRAPHIC RESEARCH		1

Rank	Activity Title	Billet Title	P-coded	Allowance
LTJG	NAV FAC CAPE HATTERAS NC	RESCH WATCH		1
LTJG	NAV FAC PACIFIC BEACH WASH	OCEANOG RES-OCEANORCHWO		1
LTJG	NAV FAC CENTERVILLE BEACH	OCEANOGRAPHIC RESEARCH		1
LTJG	NAV FAC CENTERVILLE BEACH	ALT EC WATCH		1
LTJG	NAV FAC NANTUCKET MASS	RESCH WATCH OFF		1
LTJG	NAV FAC COOS HEAD ORE	OCEANOG RES-OCEANORCHWO		1
LTJG	NAV FAC POINT SUR CALIF	OCEANOG RES-OCEANORCHWO		1
LTJG	NAV FAC RAMEY AFB PR	OPS WATCH		1
LTJG	NAV FAC SAN NICOLAS I CAL	OCEANOG RES-OCEANORCHWO		1
LTJG	NAV FAC ANTIGUA TWI	OCEANOGRAPHIC RESEARCH WA		2
LTJG	NAV FAC LEWES DELAWARE	RESCH WATCH		1
LTJG	NAV FAC ARGENTIA NEWFNDLND	OPERS WATCH		1
LTJG	NAV FAC BARBERS PT	OCEANOG RES-OCEANORCHWO		1
LTJG	NAV FAC GUAM	OCEANOG RES-OCEANORCHWO		1
LTJG	NAV FAC MIDWAY	OCEANOG RES-OCEANORCHWO		1
LTJG	NAV FAC ADAK	OCEANOG RES-OCEANORCHWO		1
LTJG	NAV FAC ELEUTHERA TWI	OPS WATCH OFF		1
LTJG	NAV FAC KEFLAVIK	RSCH WATCH		1
LTJG	OCEANOGRAPHIC UNIT 1	EXECUTIVE OFFICER		1
LTJG	OCEANOGRAPHIC UNIT 2	EXECUTIVE OFFICER		1
LTJG	OCEANOGRAPHIC UNIT 3	EXECUTIVE OFFICER		1
LTJG	OCEANOGRAPHIC UNIT 6	EXECUTIVE OFFICER		1
LTJG	OCEANOGRAPHIC UNIT 4	BOAT OFF MIL DET		1
LTJG	OCEANOGRAPHIC UNIT 5	BOAT OFF MIL DET		1
ENS	NAV FAC BERMUDA	RESRCH WATCH		1
ENS	NAV FAC BARBADOS TWI	OCEANOGRAPHIC RESEARCH WA		1
ENS	NAV FAC ARGENTIA NEWFNDLND	OPERS WATCH		1
ENS	NAV FAC GUAM	WATCH		

KEY: (1) * Indicates billet recommended for P-coding 8710P.
(2) + Indicates billet recommended for officer with oceanography education to doctorate level (8710D)

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ABSTRACT

This study into the knowledge and experience required for optimum performance by officers assigned to operational, R&D, and managerial duties in Anti-submarine Warfare concludes that oceanography should receive the major emphasis in an interdisciplinary graduate level program of the contributing disciplines in ASW. In planning education and training for officers in ASW and other oceanography-related duties the total Service experience should be considered. Oceanography graduate curricula are recommended which will provide knowledge for developing careers of three categories of officers who respectively will: "specialize" in ASW; become special duty "environmentalists"; and serve in technical management assignments. Billets are identified for each of these categories.

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